REAL WORLD INTERFACES
Musical Instrument Modifications by Robin Whittle

August 1989

DX7 MODIFIED SOFTWARE - MOD 7.1

INTRODUCTION

MOD7.1 is modified internal software for the original DX7. The software (instructions for the DX7's internal computer) provides a number of additional features and deletes a number of features of dubious value. Here is a quick summary of the features of MOD7.1

Two separate channels for MIDI out depending on which side of a split point a key is pressed. The split point is variable and internal sounds can be disabled to the left or right of the split.

Local Control OFF is provided. This means that the keyboard, controllers and patch change all drive MIDI but do not control the DX7's internal sound production. Therefore it can be used as a master keyboard while its sound producing section is operating as a slave module.

Unison Mode is the name given in many instruments for more than one note being produced each time a key is pressed - for instance the DX7-II provides two notes at a time where the second note is randomly detuned. MOD7 provides a more powerful unison facility with finer control than any instrument I am aware of. One, two or three extra notes can be played in response to MIDI or the keyboard. Each note is individually detunable by up to 50 steps of 1.17 cents. The extra notes parameters can be built into each voice (at the expense of the LFO) or can affect all voices played.

The output levels of operators can be increased to twice the normal maximum. This gives rise to more FM or a larger output signal. In a standard DX7 these larger outputs may be impractical to use because of distortion between notes, however when the sound quality improvement mods have been done, the higher output results in soft clipping of each note individually with no distortion between the notes. This soft clipping is similar to the warm distortion of a valve guitar amp being overdriven and gives rise to a new class of DX7 voices which are loud and gutsy. Each note of a chord is individually distorted, rather than the whole chord sound being distorted.

Each voice can have a volume parameter built into it, which in combination with the MIDI volume command controls the total volume in 64 even steps rather than the normal 8. A DX7 with MOD7.1 but without the sound improvement mods can make use of this if a capacitor is installed on the main circuit board, but the signal to noise ratio at lower volumes will not be very good. When the sound improvement mods have been done, this feature works properly without degrading the signal to noise ratio.

A special mode is provided where loading a specially written voice (with a # in the last character of the voice name) will set the controller sensitivities and assignments, set various other parameters, send patch changes on up to four MIDI channels, and load in another DX7 voice which can be used for playing music. This means that many of the function and MIDI parameters can be set to predetermined values simply by selecting a special voice.

Lower case and special characters are selectable for voice names.

The standard DX7 cannot transmit the full range of key velocity values - its maximum velocity output is 109 instead of 127. A keyboard sensitivity parameter allows maximum MIDI velocity to be transmitted and provides for higher velocities without the need to pound the keyboard. These higher velocities afect both the internal sounds and any slave devices the DX7 is driving. The standard DX7's reception of velocity, makes low velocities sound louder than they should, and this bug has been removed.

The portamento footswitch can be used as a program advance - to step through voices in internal or cartridge memories.

MIDI Out patch change and aftertouch (channel pressure) are individually disablable.

MIDI transmission and reception can be easily disabled.

A Stretch Tuning parameter progressivly lowers the pitches in the lowest octave and raises them in the highest two octaves, to simulate piano tuning.

The Data Entry Slider can be set to transmit on any controller number from 0 to 99 - it usually transmits on channel 6. This means you can use it to control slave devices in a flexible fashion.

Mono mode, test mode and voice init no longer exist. You can still use these features if you re-install your old ROM chip.

Active sensing receive and transmit no longer occur. The "Format Conflict" function has been removed - the DX7 will read or write cartridges no matter what they contain. For this reason, it is no longer necessary to format the cartridge, and this feature has been removed.

In Function and Play modes, the Operator Select button turns off all notes inside the DX7, and sends an All Notes Off command to all 16 MIDI channels.

The DX7 can now be made to respond correctly to the All Notes Off command from MIDI In.

Your name and phone number appears in the display when the power is turned on.

Two new ranges are available (with certain restrictions) for fixed operator frequencies. These are 0.36 Hz and a 10kHz ranges.

I can configure the MOD7.1 software so that you can select the four banks of the SYCO expansion board.

A value can be added to patch change commands sent to MIDI, so that the normal 1 to 32 (and 33 to 64 range for cartridge) range can be moved by up to 96.

INSTALLATION

Since MOD7.1 cannot generate an init voice, you may wish to create and store an INIT VOICE with your unmodified DX7 before removing the old ROM and installing MOD7.

Follow these instructions carefully - paying special attention to setting up the parameters after the MOD7.1 chip has been installed. Your DX7 may not function properly until tuning and other function parameters as well as the new parameters have been correctly set. If you experience difficulties with the installation, do not ring me until you have carefully followed the instructions at least twice.

Unplug the DX7 from the power point - there are bare wires inside the machine with 240 volts on them which may be dangerous unless the power cord is removed from the socket. Unplug all leads from the DX7. Undo the four screws on the front of the front panel, and the one near the power switch. Lift up the panel and see that it does not fall backwards.

Now for a quick guided tour of the DX7. Next to Middle C is the 63B03 microprocessor which controls the machine. To its right is a smaller 6805 computer chip which looks at the keyboard, front panel and controllers. Next to the G key below Middle C are three 24 pin memory chips which hold the internal voices, edit buffer and various other things. These are powered by the 10 cent sized lithium battery near the back of the instrument.

Above the D key below middle C is a single 28 pin ROM (Read Only Memory) chip which contains the computer program for the 63B03. It is this chip which you will be replacing shortly. Some very old DX7s had two 2764 EPROMS (Erasable Programable Read Only Memory). If yours is like this please ring me because the installation procedure below will not work for your machine.

Above the C key below Middle C is the EGS chip which processes pitch and volume information, and calculates the envelopes for the operators. Immediately to the left is the OPS chip which calculates the sine wave "Oscillators", does the volume "multiplications" and the "FM" on the pitch and volume data it gets from the EGS chip. The OPS chip sends out a separate number for each of the 16 notes a DX7 could be playing, and the area to the left of the OPS chip converts these numbers to voltages - this is the DAC (Digital to Analog Converter) which I can improve the performance of. The EGS and OPS chips are Yamaha devices specially built for the DX7/9/1/5 and TX7, TX816 series of instruments. They calculate six operators for the 16 notes 50,000 times a second. They calculate an operator in a fifth of a millionth of a second, and generate at least 10 megabytes of data a second (the Bible is 4 megabytes).

The electronics in the DX7 is sensitive to static electricity, so touch the metal chassis to discharge yourself before touching the electronics.

INSTALLATION 1 - INSERTING THE NEW CHIP

Note that the 28 pin ROM chip is mounted in a socket labelled IC14 and that there is a little notch on the right hand side. Use one or two flat bladed screwdrivers to gently lever the ROM from its socket. Replace it with the MOD7 EPROM, with the notch also pointing to the right. Check that all pins are straight and are mating with the socket before pressing it firmly in.

MOD7.1 comes with a 1uf capacitor for smoothing the volume voltage so MIDI and voice volumes can be set smoothly. The instalation is simple but requires a soldering iron - see the technicalities section - page 25. You can install this cap now or wait until later.

Replace the front panel and screws and power up the DX7. The LCD display should show the following messages :-

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V1.6 MOD 7.1b	Mods (C) 1987 by	YOUR NAME
Ph 03-459-2889	Robin Whittle	YOUR PHONE NO.

If this does not occur, then either the MOD7.1 EPROM is faulty, or you have not placed it in correctly. The notch should be pointing to the right of the instrument, and all pins should be in the socket. Remove the power plug from the socket and remove the chip to check that there are no bent pins. Re-insert it and power up again.

INSTALLATION 2 - SETTING UP FUNCTION AND NEW PARAMETERS

There are a number of different software versions for the DX7, and your old ROM may have stored its function parameters in different places to the new software you have just installed. This could mean that your DX7 will sound very weird (or not at all) at present. Carefully follow these steps to ensure that all internal parameters are correctly set.

Select Function mode and press 1 for master tune. Use the slider to set the tuning.

Press 4 for Pitch Bend Step - set it to 0 with the slider.

Press 3 for Pitch Bend Range - set it as you wish.

Press 7 for Portamento Time - set it to 0.

Press 6 for Glissando - set it to off.

Press 8 for MIDI IN, set it to 1.

Press 17 for Mod Wheel Range. Set to 0. Press 18 for Mod Wheel Pitch Assign - set to off, likewise set Amplitude (19) and EG Bias (20) to off. Repeat these steps for the other controllers - Foot, Breath and Aftertouch.

The new parameters for the MOD7.1 software are all accessed with the Function Mode and the 13 button. The parameters are changed in the usual way with the data entry slider or the + and - buttons. The INT MEM PROTECT and CART MEM PROTECT buttons are used to step through the new parameters. Since the memory MOD7.1 uses for these parameters will be full of rubbish, it is important that you set the parameters to the following values before proceeding to use the new features.

Select function mode and press the 13 button. Press the CART MEM PROTECT button three times. Now press the INT MEM PROTECT BUTTON until you see the "VOLUME EN" display - you may need to press it up to 31 times to step through all the other parameters. Use the -1 button or slider to select "VOLUME EN = 0".

Now press the CART MEM PROTECT button so that you see the "# EN" display. Set this to 0 as well. Likewise step through all the new parameters and set them to the default values shown in the table overleaf before attempting to play the DX7.

Now your DX7 should function much the same as it did before. You should enter Play mode and select a voice. It should play normally except for the better key velocity sensitivity. If this does not happen, repeat all the steps in this section before contacting me.

Function 13 Parameters

Use Internal Protect and Cartridge Protect buttons to scroll through the parameters.

Parameter Name	Default Value	Range	Brief Description	See page
SUST MODE	3	3	Enables transmission of Sustain Pedal messages :- 0 Nothing sent. 1 Lower 2 Upper 3 Lower Upper	A2
VOLUME EN	0	1	1 enables the interpretation of voice volumes.	14
# EN	0	1	1 enables the execution of # voices. Set it to 0 when you want to edit some # voices.	14
SPLIT POINT	60	97	MIDI note number of lowest key in upper section of keyboard. 60 is Middle C.	14
SPLIT MODE	0	3	Controls whether the DX7 plays notes locally when you play the keyboard. Set to 0 at power on. 0 Lower Upper 1 Upper 2 Lower 3 "Local Control Off". No notes are played locally and controller and patch change buttons drive MIDI but do not affect DX7.	15
LOWER CHAN	0	16	1 to 16 selects MIDI transmit channel for notes played below the split point. 0 selects the same channel as MIDI IN (func 8).	15
UPPER CHAN	0	16	As above but for keys on and above the split point.	15
CONT L-U	1	1	0 selects lower channel as the MIDI channel for transmission of controller and patch messages. 1 selects upper channel.	16
CHAR SET	0	2	Controls which set of characters to use when writing the voice name. 0 = normal. 1 = lowercase and special characters. 2 = weirdo random mode.	16
EXTRA NOTES	0	3	How many extra notes to play. This is for "normal" DX7 voices. Plus + voices have their own extra notes parameters and are not affected by this or the following three parameters.	16
X1 TUNE	53	99	Detune of the first extra note. 50 is normal. Each step is 1.17 cents.	16
X2 TUNE	44	99	Detune of the second extra note.	16
X3 TUNE	57	99	Detune of the third extra note.	16
STRETCH	0	8	Piano like stretch tuning.	17
PCH ADD	0	96	Number which is added to patch number in patch change message sent to MIDI out.	17
PCH OUT	1	1	0 disables the transmission of patch changes.	18
AFT OUT	1	1	0 disables the transmission of aftertouch messages.	18

Function 13 Parameters continued

Use Internal Protect and Cartridge Protect buttons to scroll through the parameters.

Parameter Name	Default Value	Range	Brief Description	See page
KEY SENS	10	19	0 is the standard keyboard sensitivity. 10 gives a better response with the full velocity range available.	18
PROG ADV	0	1	1 enables program advance with the portamento footswitch.	18
ANOFF IN	0	1	1 enables the reception of the controller 123 All Notes Off message.	19
SLOW TIMER	0	2	0 = normal, but patch changes are slower than a standard DX7. 1 = LFO and pitch envelopes run at 2/3 their normal speed but patch changes are fast. 2 = LFO and pitch envelops run at 1/2 speed and patch changes are even faster.	19
SLIDER No.	6	99	The data entry slider transmits a control change. This is the number of the controller. 6 is the standard controller number for the data entry slider.	20
FC LO	4	99	This is the controller number for the control change transmitted by the Foot Modulation Pedal, when it is being transmitted on the lower channel. 0 means do not send a control change at all.	A3
FC UP	4	99	As above but for the control change message sent on the upper channel.	A3
DES REC EN	0	1	1 enables the DX7 to receive control change 6 to perform the same function as the data entry slider. This is reset to 0 at power on.	A4

DELETED FEATURES

TEST PROGRAM

I have completely removed the test program to gain the bulk of the program space for the new features. If you want to use the test program, you should install your old ROM.

MONO MODE

Mono mode has been eliminated. MOD6 had mono mode, but the extra notes facility only applied to Poly mode. I have eliminated Mono mode to gain more space for new features. MOD7.1 neither transmits or receives MIDI commands to change between MONO and POLY modes.

ACTIVE SENSING

The MIDI specification provides for a single byte which can be transmitted every 300 msec. The idea is that if a MIDI lead is pulled out then the receiving device notices the lack of active sense bytes and turns off all notes. Most Yamaha devices transmit and respond to the sudden loss of active sensing bytes. I have removed these parts of the program since I wanted the space for extra features.

FORMAT CONFLICT - CARTRIDGE FORMAT

Before the DX7 reads or writes the cartridge, it reads the highest 6 bytes - and if it finds any of them have their bit 7 set, then it complains about format conflict and will refuse to deal with the cartridge. I have removed this code to gain extra space.

Since the DX7 will now read and write the cartridge irrespective of what data is in it, there is no need for a Cartridge Format function. If you want to "Format" a cartridge, just copy all 32 voices into it using Function 15. The DX7 still checks that every byte has been written correctly and will complain if it has difficulty writing. All bytes written to a cartridge have bit 7 set to 0, so if you write all voices to a cartridge without trouble, then you know that it is properly formatted.

VOICE INIT

MOD7.1 cannot create an init voice. The space used by the init voice in the ROM has been used for new features. Function 10 is now called "SET + & VALUES". See the section on the + voice for a full explanation.

NEW FEATURES

PANIC BUTTON

In Play or Func modes, the OPERATOR SELECT functions as a panic button. Pressing it will turn off all internal notes just as if the keys had been released and will also send all notes off commands (control change 123) to all 16 MIDI channels. In addition the MIDI volume buffer is set to the maximum value, so that the DX7 will play at full volume even though it may have recently received a low MIDI volume command.

You may get hanging notes on the DX7 or slaves under a variety of conditions - removing MIDI leads, changing MIDI parameters, stopping sequencers. The simple solution is to hit the panic button. Note that in Edit mode, the OPERATOR SELECT button does not function as a panic button.

THE + VOICE FEATURES

There are a number of features in MOD7.1 which become active when the voice in the edit buffer contains a "+" character in the last character of the name. A voice such as this is called a Plus Voice, but is referred to as a "+ voice" in this manual.

There are two ways of putting a + character there. One way is to select CHAR SET = 1 and write a + with the button which used to write a full stop. An easier and better way is to enter function mode and press button 10 and then press Yes twice - just as you would have to create an init voice. When you execute this function - now named "SET + & VALUES", a + is written into the last character of the voice name, and five voice parameters are set to certain values. So to set a + character in the voice name, select Function 10 and press the Yes button when you see the "SET + & VALUES" message.

Five parameters behave differently in a + voice - they are LFO SPEED, DELAY, PMD, AMD and Pitch Mod Sensitivity. As long as there is a + sign in the last character of the voice name, then these parameters have different functions, and the LFO is disabled. Furthermore, the display you see when editing these parameters is changed to reflect their new function.

The "SET + & VALUES" function is the best way to change a voice into a + voice, since it stops any LFO activity which may have carried over during edit mode from the original voice. If you use the character buttons to write a + into the voice name, the LFO could remain active while you edit the voice, and play havoc with very low fixed frequencies.

VOICE PARAMETER IN NORMAL VOICE	NEW FUNCTION IN A + VOICE	DEFAULT VALUE WHEN "SET + & VALUES" IS USED
LFO SPEED	EXTRA NOTES	0
LFO DELAY	X1 TUNE	53
LFO PMD	X2 TUNE	44
LFO AMD	X3 TUNE	57
LFO PITCH MOD SENS	VOICE VOL	7

If a + voice is being played, then the Extra Notes, and X1, X2 and X3 tune parameters which are accessed via Func 13 are ignored - MOD7.1 plays extra notes as directed by the old LFO paramters in the voice. The Func 13 parameters are not changed, but are not used when a + voice is being played.

So now there are two places in your DX7 where there is a set of Extra Notes parameters. One set is in the new parameters accessed via Func 13. This set controls the number of extra notes and the tuning of extra notes for voices which are not + voices. There is one set of these in the DX7.

The second set of Extra Notes parameters is in what was the LFO area of the voice if the voice has a + in the last character of its name. When you save the voice, to internal or cartridge memory, or via MIDI to another DX7 or computer system, this information remains part of the voice. Whenever that + voice is played by a MOD7.1 equipped DX7, it will play extra notes according to this set of parameters.

For instance you may take a string sound, use the "SET + & VALUES" function and set the Extra Notes parameters to give three extra notes with tunings of 56, 44 and 48. You can save that voice, and since it now has a + in the last character of the voice name, MOD7.1 will play four notes each time you press a key. If you play that voice on a standard DX7, it will interpret the numbers as an LFO speed of 3, a delay of 56, a PMD of 44 and an AMD of 57. This will probably sound horrible.

There are two ways that a voice volume can be built into a voice, and in a + voice, it is stored in what used to be the LFO Pitch Mod Sensitivity parameter which is renamed Voice Volume. This will have effect when the VOLUME EN parameter of Func 13 is set to 1. See the Voice Volume section for further details.

There are two other MOD7.1 features which are only active in a + voice - new fixed frequency ranges for operators, and new higher operator output levels.

NEW FIXED FREQUENCY RANGES IN + VOICES

Fixed frequencies are used in many voices for two quite distinct purposes. When a frequency such as 2818 Hz is used in the SUPERPIANO voice, the effect is an audible "nasal" effect on the overall sound.

A second - and I believe more valuable - use of fixed frequencies is to use a very low fixed frequency for the bottom operator in algorithms 16, 17 and 18. By using a 1 Hz for OP1 and frequency modulating it back and forth with the other operators, sounds can be achieved with a special quality which cannot be obtained by any other means. The 1 Hz carrier adds a warbling effect to the sound and I have often felt it would be nicer if this warbling could be a bit slower. MOD7.1 makes it possible to select a fixed frequency of as low as 0.36 Hz in a + voice. It also makes a 10kHz range available as well.

To set a fixed frequency, edit the FREQUENCY COARSE and select which operator you wish to deal with. By pressing OSC MODE/SYNC, and pressing the Yes button, you can select the Fixed Frequency mode of operation. If you change FREQUENCY FINE to the minimum possible value and then use the slider to edit the FREQUENCY COARSE parameter, you will find that according to the display, are only four possible fixed frequency ranges - 1 Hz, 10 Hz, 100 Hz and 1000Hz. There are actually 32 possible FREQUENCY COARSE values, and in a normal DX7, the four ranges appear 8 times.

MOD7.1 interprets a normal voice (a voice which does not have a + in the last character of the display) in exactly the same way, so that it retains compatability with normal DX7 voices. With a + voice however there are an extra two ranges of fixed frequency and they form a group of 8 which is repeated 4 times to give the 32 possible FREQUENCY COARSE settings. The very lowest four are identical to the original ranges, but the next four include two new ranges.

FREQUENCY COARSE IN RATIO MODE	FREQ COARSE IN NORMAL VOICE	IN FIXED MODE + VOICE	
7.00	1000 HZ	10 KHZ	New range
6.00	100.0 HZ	100.0 HZ	
5.00	10.00 HZ	10.00 HZ	
4.00	1.000 HZ	0.36 HZ	New range
3.00	1000 HZ	1000 HZ	
2.00	100.0 HZ	100.0 HZ	
1.00	10.00 HZ	10.00 HZ	
0.50	1.000 HZ	1.000 HZ	

Note that the display does not change at all - you will need to step to the bottom of the FREQUENCY COARSE range and then step up four to be sure of being in the 0.36 Hz range. In a + voice, the ranges repeat every eight steps, so for instance, the 13th step from the bottom is also a 0.36 Hz range.

If you are modifying an existing voice to a + voice, I suggest checking to see if it uses fixed frequencies. If it does, check that the FREQUENCY COARSE settings are in the bottom four steps so that the new interpretation MOD7.1 puts on steps 5 and 7 (and 13 and 21 etc) will not affect the sound.

There are a few restrictions on the use of the new ranges which could give you unexpected results if you are not careful. If you go too high in the 10 kHz range, the circuitry in the EGS chip will overflow or "go around the clock" to give a very low frequency. The 10 kHz range is quite capable of producing frequencies up to about 25 kHz before it wraps around to 0.36 Hz, and you should be wary of turning up the volume on signals you cannot hear - you may infuriate the local dogs or cook your tweeters.

The very bottom of the 0.36 Hz range - where the FREQUENCY FINE reads 1.000 Hz - is in fact as low as the DX7 hardware will go. Fixed frequencies are not affected by master tune, pitch envelope or transpose, but they are affected by DETUNE, PITCH BEND and LFO. If you select the lowest possible fixed frequency and have a negative detune, the EGS chip will wrap around backwards to 25 kHZ. Likewise if you intend to be pitch bending a voice, make sure that the lowest fixed frequency is high enough to withstand being pitch bended (bent?) down without hitting 25 kHz. There is no danger to the DX7 in this, but you will hear a loud click when it happens, and the character of the voice will immediately change. Normally the LFO and controllers could also cause pitch changes which would have the same effect, but the LFO is disabled in a + voice.

HIGHER OPERATOR OUTPUT LEVELS IN A + VOICE

In a + voice, the operator output levels 1 to 15 have a changed meaning, - they all provide for output levels up to twice the normal maximum which is reached with 99. 1 is slightly above 99, 2 is slightly higher, and 15 is twice as high as 99. The 0 to 99 range of the envelope generators is not affected by this change.

If you are changing an existing voice into a + voice and you notice a dramatic change in sound, then check the operator output levels - there could have been one set to somewhere between 1 and 15, which in the original voice was quite inaudible, but now has a very high level due to the new interpretation of these levels in a + voice.

There are several implications of having higher operator output levels. If the operator is modulating another, then the result will be a wider "Frequency Modulation" than normal, and this can be particularly important when a low fixed frequency is used as a carrier on the bottom line of the algorithm. Higher ouptut from the modulator results in a brighter more complex tone than can be achieved with normal levels.

If you boost the output levels of OP1 in ALG 16, 17 or 18, then there are a number of implications. Firstly on a standard DX7 (one without the Sound Quality Improvements) you will get a higher level for each note, but you may get some distortion within the note. If you play lots of notes, then you will run into intermodulation distortion between the notes, which is usually an unpleasant sound. Other algorithms are similarly affected if the output levels of the operators on the bottom line are high enough for the total output when all operators are in phase to exceed the normal maximum.

When the Sound Quality Improvement mods have been done, the situation is changed significantly. The mods accomodate the 99 level without distortion or intermodulation between notes, at a much higher signal level than the standard DX7 (hence the improved signal to noise ratio). If the level is driven much above 99 then the signal of each note is soft clipped symetrically. (Sound Mods done before 9-87 can be modified to give the soft clipping). This is roughly the equivalent of putting each note through its own overdriven valve amplifier and mixing the output of the amplifiers. There is no intermodulation between notes.

For a detailed description of what is happening here, see the Technicalities section of this manual. The musical result is that with the Sound Quality Improvement mods, and MOD7.1, the DX7 can make a whole new class of sounds which are edgy, loud, unique and (dare I say it?) extremely FAT.

VOICE VOLUME

When VOLUME EN = 0, the DX7 will run at full volume (multiplied by the most recently received MIDI volume).

If VOLUME EN = 1, then MOD7.1 looks for two possible ways of building the volume into the voice. In each case there are 8 possible volumes, where each step down corresponds to about a 3dB drop in level on a DX7 with the sound improvement modifications.

In a + voice, the voice volume is stored in the LFO Pitch Mod sensitivity - Edit number 15. This has levels from 0 (quiet) to 7 (full volume). When a + voice is being editted, this parameter is now displayed as "VOICE VOL", and when the SET + & VALUES function is executed, this parameter is set to 7.

In a voice which is not a + voice, the voice volume is built into the last character of the voice name. There are 8 characters of special significance for this, any other character (or a space) means that the voice volume will be maximum. The characters are the lower case o, p, q, r, s, t, u and v. These correspond to the 0 to 7 range of voice volumes in a + voice. If you find that one of your voices has become extremely quiet since you installed MOD7.1, then perhaps it has one of these characters in the last character of its name. For instance a voice named "Good Cello" has "o" as its last character which would make it very quiet if VOICE VOL = 1.

Below is a list of the two different forms of voice volume, and the approximate output level in dBm (0dBm = 0.776 volts RMS) which the voice volumes produce on a DX7 (with the sound improvement modifications) with the volume turned up fully. The voice is an ALG 18, maximum volume (EG and output level = 99) voice. + Voices with higher output levels, or extra notes will be above these levels.

VOICE VOLUME IN + VOICE	VOICE VOL IN NORMAL VOICE - LAST CHARACTER IN NAME	APPROX OUTPUT LEVEL dBm
7	v	0
6	u	-3
5	t	-6
4	s	-9
3	r	-13
2	q	-16
1	p	-20
0	o	-24

I believe that this new scheme will provide sufficient control for attenuating loud voices.

Note that in a DX7 with the sound mods, voice volume and MIDI volume will only affect the output level if there is nothing plugged into the foot volume socket. If your DX7 does not have the sound mods, then you will need to install the 1uf capacitor - see the technicalities section for a complete discussion of this and other volume issues.

THE # (HASH) VOICE

If the # EN parameter is set to 1, and a voice is loaded which has a # (hash) sign in the last character of the name, then that MOD7.1 uses that voice's parameters to set up various things, and then loads in another voice. This takes about half a second, but is a lot faster if SLOW TIMER = 1 or 2.

The # voice is intended for live use where you want to be able to set a lot of things quickly and reliably, and are prepared to put a bit of time into creating # voices beforehand.

To create a # voice, firstly set # EN = 0. Then load a voice and put a # in the last character of the voice name. You can get a # character by setting CHARSET = 1 and pressing the 4 button. I suggest you make an initial # voice and save it somewhere for future use.

It is a good idea (although not essential) to set all the operators to fixed frequency 1Hz, with OSC KEY SYNC = OFF, and to set ALGORITHM = 32 and all the operator output levels to 0. These precautions will stop the # voice making objectionable noises when you load it.

It is important to note that the # voice is not for playing music with - do not attempt to modify an existing voice into a # voice. The # voice is a macro command for MOD 7 software to set up various values, and then to automatically load in another voice so that you can play music.

The important part of the # voice is the rates and levels of the six operators. This area contains 48 parameters of which 29 are currently used to set up various things in the DX7 and optionally in slave devices. The map below shows which parameters are used for what purposes.

OP1		OP1	
Rate 1	MOD WHEEL RANGE	Level 1	SPLIT POINT
Rate 2	MOD WHEEL ASSIGN	Level 2	SPLIT MODE
Rate 3	FOOT RANGE	Level 3	LO CHAN
Rate 4	FOOT ASSIGN	Level 4	UP CHAN
OP2		OP2	
Rate 1	BREATH RANGE	Level 1	CONT L-U
Rate 2	BREATH ASSIGN	Level 2	VOLUME EN
Rate 3	AFTER TOUCH RANGE	Level 3	STRETCH
Rate 4	AFTER TOUCH ASSIGN	Level 4	PITCH BEND RANGE
OP3		OP3	
Rate 1	NEXT VOICE NUMBER TO LOAD	Level 1	EXTRA NOTES
Rate 2		Level 2	X1 TUNE
Rate 3		Level 3	X2 TUNE
Rate 4		Level 4	X3 TUNE
OP4		OP4	
Rate 1		Level 1	CHAN) SLAVE SELECT 1
Rate 2		Level 2	PATCH)
Rate 3		Level 3	CHAN) SLAVE SELECT 2
Rate 4		Level 4	PATCH)
OP5		OP5	
Rate 1		Level 1	CHAN) SLAVE SELECT 3
Rate 2		Level 2	PATCH)
Rate 3		Level 3	CHAN) SLAVE SELECT 4
Rate 4		Level 4	PATCH)
OP6		OP6	
Rate 1		Level 1	
Rate 2		Level 2	
Rate 3		Level 3	
Rate 4		Level 4	

For instance if you set OP1 Rate 1 to 75, and execute the # voice, (by loading it when # EN = 1) then the DX7 function parameter for MOD WHEEL RANGE will be set to 75. Likewise for the other three ranges.

The controller ASSIGN is a bit more complicated. There are three bits for each controller, and therefore 8 possible combinations of off and on. I suggest that you keep to the range 0 to 7 for these parameters.

VALUE OF ASSIGN PARAMETER	PITCH	AMP	EG BIAS
0			
1	ON		
2		ON	
3	ON	ON	
4			ON
5	ON		ON
6		ON	ON
7	ON	ON	ON

There are four pairs of CHAN and PATCH in the OP4 and OP5 Levels. These are used to select patch numbers on slave MIDI devices. If the CHAN parameter is 0 then the pair is ignored, while if the CHAN is 1 to 16, then a patch change is sent on the appropriate channel. CHAN values of 17 to 32 etc. have the same effect as 1 to 16. I suggest that you keep the CHAN values within the range of 0 to 16.

The PATCH values of 1 to 99 select the appropriate patch number, while a PATCH value of 0 actually selects patch 128.

So by selecting a # voice, you set up the controller ranges and assignments, the split, MIDI, extra notes and various other parameters. The last thing that MOD7.1 does is to load in another voice to replace the # voice.

OP3 Rate 1 controls this function and with values between 1 and 32 it will select a voice from the currently selected INT/CART memory. If the value is 0 then the next highest voice number will be loaded, and the same will happen if the # voice tries to load itself.

If you select split mode 3 - local control off - then you will not be able to make the DX7 load another voice from the front panel. You could change the Split Mode parameter using Func 13, or if you are really organised, a sequencer could be sending patch changes to the DX7 and that patch change could select a # voice which sets things up as you like.

Under no circumstances should you have a memory bank or cartridge full of # voices - MOD7.1 (if # EN =1) would continually load each # voice in succession, .

MIDI ON AND OFF

This facility can be accessed at any time to turn ON or OFF the transmission and reception of MIDI. MIDI THRU is unaffected and operates at all times.

To turn MIDI IN and OUT OFF -

Press and hold STORE, press INTERNAL MEM PROTECT, and release both buttons.

To turn MIDI IN and OUT ON -

Press and hold STORE, press CARTRIDGE MEM PROTECT, and release both buttons.

MIDI is disabled when the DX7 is turned on, and enabled when the MOD7.1 and owner messages have been sent to the display. This inhibits the burst of note off events that usually comes from the DX7 at power on, and ensures that MIDI is enabled when the power is turned on. There is no visible sign of whether MIDI is enabled or disabled, but there will be little confusion since turning it on and off are quite different operations, and it doesn't hurt to turn it on a second time if you can't remember which state it was in.

You can turn MIDI on and off no matter what state the machine is in. Whenever you do either, all local notes are turned off. All notes off commands are not sent to MIDI, so if you hold some keys down and turn MIDI off, you may get stuck notes on slave instruments.

MEMORY BANK SELECT

MOD7.1 can be configured to select the four banks of the Syco memory board. This means that you can remove the Syco EPROM and plug in the MOD7.1 EPROM and still have access to the four internal banks. MOD7.1 does not receive patch changes 1 to 128 and map them into the four internal banks. The MOD7.1 bank numbers 0, 1, 2 and 3 correspond to Syco banks 4, 3, 2 and 1.

I can modify the DX7 to contain 16 banks of internal voices - 512 read/write voices. The bank number is controlled by a suitably configured MOD7.1, and the banks are numbered 0 to 15.

In both cases, the bank number is controlled by Func 12. If MOD7.1 is configured to select memory banks, then the LCD display shows the bank number in play mode when internal memory is selected much as the Syco system does. If you select Func 12 and then go back to play mode, you will still be able to select the bank number with the + and - buttons and the data entry slider, but since the LCD display is not continuously updated, you will not see the bank number in the display change unless you cause the display to be updated. One easy way is to press and release the store button. Whenever you select a voice the display will be updated as well.

NEW PARAMETERS

VOLUME EN

VOLUME EN = 0 The DX7 always plays at maximum volume, unless it receives a MIDI volume change command. If your DX7 does not have the Sound Quality Improvement mods, or if the 1uf cap has not been installed, then you should leave VOLUME EN set to 0.

VOLUME EN = 1 MOD7.1 looks at voice volume (see page 10) and multiplies that value with the most recently received MIDI volume change, to arrive at a final volume for the instrument.

The MIDI volume change command for the DX7 is controller number 7, and each time one of these is received, it is stored in a memory location and combined with the voice volume to create a final volume. Whenever you change the VOLUME EN parameter, or press the Panic Button (Operator Select in Play or Func mode) the MIDI volume memory location is set to maximum.

For a full discussion of volume issues, see page 10 and the Technicalities section - page 24.

EN

EN = 0 Disables the special interpretation MOD7.1 gives to # voices. Be sure to set # EN = 0 before trying to edit a # voice.

EN = 1 When a # voice is loaded, MOD7.1 uses it to set up internal parameters and send patch change commands to slave MIDI devices. See the # voice description on page 11.

SPLIT POINT

The split point affects the MIDI channel used for transmitting note events. The number is the MIDI note number of the key which is the lowest of the upper section of the keyboard.

SPLIT POINT = 60

This sets the split point to Middle C. Keys above and including Middle C will be transmitted on a channel determined by the UPPER CHAN parameter. Keys below the split point are transmitted likewise on the channel determined by LOWER CHAN. See the last page of these instructions for a table of keys and MIDI numbers.

SPLIT MODE

SPLIT MODE = 0 Local notes are played for all keys struck.

SPLIT MODE = 1 Local notes are played only keys to the right of and including the split point. Split Mode 1 is the one you would chose if you wanted to play the DX7 on the upper part of the keyboard, and drive an external device on the lower without making a sound on the DX7.

SPLIT MODE = 2 Local notes are played only on keys to the left of the split point.

SPLIT MODE = 3 "Local Control Off". No sounds are made on the DX7. Note events are transmitted as usual on a channel determined by the split point and Upper and Lower Chan parameters. Controllers, pitch bend, and patch changes are transmitted on either the lower or upper channel as determined by the CONT L-U parameter - see below.

The controllers and patch change do not affect the DX7's sound circuitry (except for the portamento footswitch). In play mode, if you press a voice button, a patch change for that number will be sent to MIDI, but the DX7's internal voice will not change. A similar situation exists if you use the portamento footswitch program advance - a MIDI out patch change will be generated for the voice number one above the DX7's internal voice, but the internal voice will not change.

Split mode 3 enables the DX7 sound circuitry to be driven from MIDI IN independently of what you are doing on the keyboard, controllers and patch change. You can use the DX7 as a master keyboard while its sound section functions as a slave module playing notes from a sequencer.

Changing the Split Mode parameter while holding keys down could cause hung notes locally. Use the panic button if this occurs.

SPLIT MODE	LOWER KEYS MAKE LOCAL NOTES?	UPPER KEYS MAKE LOCAL NOTES?	PCH & CONTROLLERS AFFECT LOCAL NOTES ?
0	YES	YES	YES
1	NO	YES	YES
2	YES	NO	YES
3	NO	NO	NO

11-11-91

MOD7.1D sets SplitMode to ∅ at power on.

LOWER AND UPPER CHANNELS

These parameters control which channel notes and other information is sent on via MIDI OUT. They have no effect on the reception of MIDI IN. The original MIDI parameter (function 8) affects MIDI reception and has been renamed MIDI IN.

Each parameter can be from 0 to 16, where 1 to 16 are MIDI channels and 0 means "use the same channel as MIDI IN".

Changing MIDI parameters while notes are playing can lead to hung notes, so use the panic button (Operator Select) if necessaray.

Watch out for MIDI loops - the DX7s MIDI Output somehow coming back to its Input on the channel it is receiving on - this can cause drama such as :-

Two identical notes playing for every key you press.
Values incrementing by two every time you press the yes button.
MIDI receive or transmit channel parameters "skipping" a particular channel when you change them with the Yes/No buttons.

CONT L-U

CONT L-U = 0 The LOWER chan is used for transmission of patch change, and controller data.

CONT L-U = 1 The UPPER chan is used for transmission of patch change, and controller data.

When you are using the DX7 as a master to control two MIDI slave devices, you may wish to have a convenient way of selecting patches on the slaves. By entering Func 13 and selecting this parameter, and then re-entering Play mode, you can press voice buttons to send patch changes and use the - and + buttons to change the CONT L-U parameter. Even though you are no longer in Func mode, the + and - buttons and the `slider still control the most recently selected function parameter.

CHARACTER SET

CHAR SET = 0 Normal characters for voice names.

CHAR SET = 1 Lower case and special characters for voice names.

CHAR SET = 2 Weird Mode, unfortunately some of the exotic characters accessed in this mode will not survive being written to a cartridge or to MIDI.

CHAR SET 0	CHAR SET 1	
1	<	Less than sign
2	>	Greater than sign
3	*	Asterisk
4	#	Hash sign
5	@	Ampersand
6	,	Comma
7	"	Double quote
8	!	Exclamation mark (also know in some Circles as Bang)
9	?	Question mark
0		Yen
A	a	
Z	z	
-	=	Equals

EXTRA NOTES - "UNISON"

The EXTRA NOTES parameter enables 1, 2 or 3 extra notes to be played locally (on the DX7 sound circuitry). This will happen irrespective of whether the keyboard or MIDI IN caused the original note to be played. EXTRA NOTES does not affect MIDI OUT - only one note event is transmitted. This set of four parameters is ignored if a + voice is loaded - the + voice has its own extra notes parameters.

Each extra note has an individual detune parameter, where 50 is normal and each step is the minumum pitch step of the DX7 sound chips - 1.171875 cents (A cent is 1/100 of a semitone). There are 256 steps in three semitones. This gives a detune range of + or - about 58 cents. The X1, X2 and X3 TUNE parameters immediately follow the EXTRA NOTES parameter.

EXTRA NOTES = 0 Normal mode. The DX7 plays a single note for each keystroke or MIDI IN note on event. As usual the DX7 is 16 note polyphonic.

EXTRA NOTES = 1 The DX7 plays two notes at a time, and the second one can be tuned using the X1 TUNE parameter. Polyphony is eight notes.

EXTRA NOTES = 2 The DX7 plays three notes at a time, and the second and third ones can be tuned using the X1 and X2 TUNE parameters. Polyphony is five notes.

EXTRA NOTES = 3 The DX7 plays a total of four notes and polyphony is reduced to four.

Since it takes around 1.5 millisecond (ms or 1/1000 second) to fire up each sound channel to make a new note, the notes do not start at exactly the same time. If all the tunings are set to 50 and EXTRA NOTES is set to 1, 2 or 3, then the result will sound like a pipe or fixed flange. Slight deviations from 50 will cause a moving flange or chorus sound.

Two or three extra notes with tunings of for instance 53, 57 and 46 can add a great deal to "strings" and "cello" sounds. It is a common complaint that the DX7 can't do good string sounds, but the EXTRA NOTES facility can make a big improvement in this area.

Piano sounds can be given a greater depth of detail with 2 or 3 extra notes and a little detune. Larger detunes give a definite honky tonk flavor.

Bass sounds can benefit greatly from 2 or 3 extra notes, with slight detunes as for the strings.

The voice parameter OSC KEY SYNC is usually of little importance when the DX7 is playing one note at a time, but can be a very important issue when extra notes are started at almost the same time. This parameter is accesed in Edit mode via the 17 button. With OSC KEY SYNC = OFF, the operator oscillators start with random phases at the start of the note, but if this parameter is on, then the sine waves all start from 0 and go up at the start of the note.

With OSC KEY SYNC = ON, all the notes have identical waveforms and their low frequencies add together. The higher frequencies are more affected by the difference in starting times of the notes, and are subject to a comb filter effect rather than addition. So for sounds where you want an initial bottom-end unity and punch - for instance "piano" and "bass" sounds, set the OSC KEY SYNC to ON. The first parts of the notes are all identical until the detuning (if the tunings differ from 50) makes the waveforms go out of phase.

Where diversity and randomness is more important, such as for a "string" or "brass" ensemble effect, you would probably be better off with OSC KEY SYNC = OFF.

STRETCH TUNING

The stiffness of a piano's strings causes the higher harmonics to be higher than simple integer multiples of the first harmonic. So the 8th harmonic of a 100 Hz string might be 810 Hz rather than the 800 Hz one might otherwise expect. In addition, when the string is vibrating all harmonics are frequency modulated by the tension of the string which is an always positive sum of the instantaneous levels of all the harmonics in both X and Y directions. Similar effects take place to one degree or another in any plucked string instrument. The resulting complexity can only be approached by a DX7, and the always positive FM can never be achieved.

To try to make the piano harmonise better with itself, and its sharp high harmonics, most pianos are tuned with their high notes sharp and their low notes flat. Although I do not fully understand how this is approached, I have implemented a stretch tuning parameter in the hope that it will be of some value.

The parameter progressively flattens notes below C2 (Middle C is C3) and progressively sharpens those above C4. Therefore the top two and the lowest octave of the keyboard are affected. I have doubled the flattening rate of the lower octave because it sounded better to me. I request your feedback on this scheme.

PCH ADD

PCH ADD = 0 When you select a voice from the front panel, and the DX7 sends a patch change command to MIDI out, the patch number is the same as usual - internal patches are 1 to 32, cartridge patches are 33 to 64.

PCH ADD = 64 The PCH ADD parameter is added to the patch number sent to MIDI so that now the internal voices will send 65 to 96 and the cartridge will send 97 to 128.

This will be useful if you want to select patches above 64 in slave instruments. Many instruments have presets below 64 and user programs above. PCH OUT must be set to 1. PCH ADD and PCH OUT do not affect the patch changes sent when a # voice is loaded.

PATCH CHANGE AND AFTERTOUCH MIDI OUT ENABLE

PCH OUT = 0 No patch change will be sent via MIDI OUT when a new patch is selected. If SYS INFO is set to AVAIL, then the complete voice data will still be sent.

PCH OUT = 1 Normal mode. Selecting a new patch on the front panel or via the portamento footswitch will cause a patch change to be sent via MIDI OUT (assuming SYS INFO is set to UNAVAILABLE.

AFT OUT = 0 No aftertouch (Channel Pressure) messages are sent from MIDI OUT.

AFT OUT = 1 Normal mode. Aftertouch messages are sent out when the after touch sensor pressure is changed - virtually all the time when the keyboard is being played.

Disabling the patch change out could be handy when driving slave instruments. The Aftertouch messages make up the majority of MIDI OUT data and are rarely used. Disabling them may make life easier for slave MIDI devices as well as the DX7.

KEY SENSITIVITY

With the standard software, it is difficult to hit the keys hard enough to get a high velocity value, and impossible to get maximum velocity from the keyboard for either the local notes or MIDI out.

The 6805 computer measures the time it takes between one key contact opening and a second one closing, and reports this to the main computer system. There are three scaling tables - one to turn time into internal velocity, a second to turn time into MIDI OUT velocity and a third to turn MIDI IN velocity into internal time. Ideally I would like to re-write these lookup tables and make them finer and more accurate, but this would take more space than is currently available.

The best solution is to subtract the Key Sensitivity parameter from every key time which the 6805 reports, this hardly affects the slower times, but makes the shorter times seem much shorter indeed.

KEY SENS = 0 Normal keyboard response.

KEY SENS = 5 - 10 Higher internal velocities and MIDI OUT velocities can be achieved. I generally leave it around 10.

Note that this parameter affects internal notes and MIDI OUT velocities. It has no effect on velocities coming from MIDI IN.

PROGRAM ADVANCE BY PORTAMENTO FOOTSWITCH

PROG ADV = 0 Portamento footswitch works normally.

PROG ADV = 1 Portamento footswitch does not affect portamento but advances the voice to the next highest voice number.

The voice number is incremented each time, until it reaches 32 when it returns to 1. INT or CART selection is unaffected. The system reads the current internal voice number, adds 1 and "presses" the appropriate button. Note that in Split Mode 3, the program advance will select one higher than the current local voice number, but that the local voice number will not change (3 means local control is off). So the program advance will not keep advancing with local control off unless the patch change is echoed to MIDI IN.

ALL NOTES OFF - ANOFF IN

ANOFF IN = 0 The DX7 does not respond to the All Notes Off command.

ANOFF IN = 1 The DX7 turns off all local notes when it receives an All Notes Off command.

The MIDI specification defines a control change number 123 with a value of 0 as an All Notes OFF command (hereafter called ANOFF). Although the specification does not define when this command should be used, it does say that all instruments should respond to it. Many Yamaha instruments, and the Poly 800 are notorious for ignoring this command.

The ANOFF command is not usually something which is initiated by a musician (although the MOD7.1 panic button generates it for all 16 channels), and it is not usually recorded like other control changes. ANOFF is usually sent by sequencers at the end of the sequence, or if the sequence is stopped manually to ensure that no notes are being held on slave instruments. For instance if you stop the sequencer halfway through a chord, then the sequencer will never send the note off events which turn off the chords notes. The sequencer will send ANOFF in the hope that all notes will stop immediately. The standard DX7 takes no notice of this and will continue to play the notes. Even if the notes fade away like a piano sound, they will still be taking up some of the 16 sound channels and can cause problems when a new voice is loaded. The only solution in a standard DX7 is to turn the machine off.

With ANOFF = 1, the DX7 responds to a control change 123 (irrespective of its value) by turning off all local notes. If the ANOFF command was only sent when a sequencer stopped, then ANOFF reception would always be a good thing. Unfortunately however there are many devices which send the ANOFF command in the middle of a piece of music - and this can cause trouble if the receiving instrument always responds to the ANOFF command.

The Roland MSQ-100 sequencer for instance seems to keep a check of what notes are currently being played on each channel - for instance if its sequence memory contains three note on events followed by three corresponding note off events, then after the last note off event has been sent, the MSQ-100 decides that there should not be any notes playing, and so it sends an ANOFF command just to make sure. Unfortunately it is not smart enough to take into account the possibility of the sustain pedal (controller 64) being pressed during the chord, and being released sometime after the last note off event. If the instrument responds to the ANOFF command, then all notes will be turned off after the last note off event, rather than when the sustain pedal was released. I believe that Roland master keyboards and sequencers use ANOFF in the same way.

In general you should leave ANOFF IN set to 1, but if you encounter chopped off notes when using the sustain pedal, then you may need to set it to 0. You can always hit the panic button (OP Select in Play or Func mode) to clear any hanging notes.

SLOW TIMER

SLOW TIMER = 0 Normal operation. Due MOD7.1's smooth volume function, patch changes are slower than a standard DX7.

SLOW TIMER = 1 Patch changes happen much faster now, but Portamento and Pitch Envelopes run one third slower.

SLOW TIMER = 2 Portamento and Pitch Envelopes run at half speed, but the loading of voices is much faster.

The 63B03 computer contains a timer which is normally programmed to interrupt the main program every 3 msec. When it does so, the computer spends a lot of time running some complicated code which maintains the LFO and pitch envelopes, and computes pitch bend and portamento. In MOD7.1 there is some additional code which drives the smooth volume function. By the time it has finished all that and returned to the main program loop, it is almost time for another timer interrupt. The main loop is concerned with responding to front panel controls, loading and editing voices, and responding to MIDI IN data. Consequently only a small proportion of computer time is available for these operations, and loading a voice can take about 0.4 seconds. Some people find this too long.

The SLOW TIMER = 1 (4 msec) and 2 (6msec) settings cause the timer to interrupt less often, and so more time is available for voice loading - in this mode you will be able to run your finger across the voice buttons and see every voice loaded, rather than just a few. In these modes however the Pitch Envelopes and LFO will be slower than normal, and you will need to adjust the LFO and PEG parameters in each voice to compensate.

SLIDER No.

SLIDER No. = 6 The data entry slider is sent as usual as Control Change 6 to MIDI OUT.

This parameter enables you to make the data entry slider transmit on any controller number from 0 to 99. The Yes and No buttons are unaffected - they are controller numbers 96 and 97 respectively. If you wish to adjust the SLIDER No. parameter with the slider, you may be advised to turn MIDI off while you do so to avoid sending values to the controller numbers you are sliding through.

The Casio CZ instruments always receive Controller 6 as a tuning value. Unfortunately the DX7 and other Yamaha instruments always transmit any new data entry slider position as Controller 6. Consequently any CZ slave is retuned (ie. detuned) every time you move the data entry slider.

If you set this parameter to 7, then the CZ101, CZ1000 and CZ5000 will ignore it. Control change 7 is received by the DX7 and other instruments such as the TX7 and TX816 as the MIDI volume command. You will need to consult the MIDI spec of slave instruments to find out which controller numbers they receive. See the Technicalities section for further details.

When you modify this parameter, it is highly likely that the next thing you will do is to try to send slider information so some other device. However, unless you are careful, your movements of the slider will change the slider number - leading to confusing results. So I suggest that once you have selected the slider number, you press button 14 - Battery Check so that slider movements will not upset the slider number.

TECHNICALITIES

GENERAL

The MOD7.1 code is based on the version 1.6 code (ROM type IG11464) which is used in most DX7s. There is a version 1.8 which can be bought from Yamaha and supposedly fixes the problem of stuck notes on slave instruments. I do not know if this is in fact true.

It is not possible to make the DX7 EGS and OPS chips play two different sounds at once. There is an English DX7 upgrade board which some people believe can play two different voices at once. This could only be achieved with an additional pair of EGS and OPS chips - and probably a larger power supply. Another impossibility is separate LFOs for each note.

An important design requirement of MOD7.1 is that the user should be able to install it without modifying the DX7 hardware, and that it should be possible to reinstall the original ROM chip. Ideally I would have liked the extra space of a 27256 EPROM to add extra features, but this would require changes to the DX7 main board. Constrained by the 27128 I have found it necessary to remove existing features to gain space for the new features I have added. MOD7.1 contains about 2K of new code and there are only about 20 bytes spare (from a total of 16K). Further improvements will require the axing of other features - the last one which I consider dispensable is portamento.

I would like to improve on the present "lumpiness" in the DX7's response to high key velocities, but this requires a lot of space for three longer lookup tables. I would also like to add a facility for alternative tunings, but this would take up a lot of code space as well.

I have aimed with MOD7.1, and the Sound Improvement Modifications to provide new sounds, highest possible sound quality, MIDI flexibility and ease of use on stage. Although I use my DX7 purely in a home recording setup, I hope that I have been able to satisfy the needs of many DX7 owners. We all have different priorities, and different ideas about music, and I welcome your comments.

My list of possible improvements (in no particular order) are :- A440 to be indicated when adjusting master tuning. A store mode where holding store and pressing a button shows you the name of the voice you are about to overwrite, and pressing the op select button would actually store the voice. An alternative store mode where pressing store and the opselect button stores the voice one location beyond where the previous store occurred. I would like to clean up the key velocity system and make it respond more linearly and smoothly than it does at present. Naturally I would like to provide alternative tuning schemes, but the questions of how to edit and store this data need to be resolved.

UPDATES, COPYRIGHT AND OWNERS NAME CHANGES

There is virtually no room left in the EPROM to expand on MOD7.1. I have made a special version to transmit the sustain pedal on both upper and lower channels, and another version which transmits the foot controller on upper and lower channels as controller 7 for volume. With additional hardware, I have made the DX7 respond quickly to MIDI volume commands - with a special response curve to suit the Yamaha wind controller.

In the distant future I plan a DX7 upgrade which will contain extra memory, sound improvements and new software on an easily installed - and easily exported - board. This will do all the things MOD7.1 does, but may do them differently, and will do many other things besides. The software will be written so that it will run with the sound mods and memory I am currently installing, so that MOD7.1 users will be able to upgrade without great expense.

MOD7.1 is a software product, and as such can be easily copied. This is against the law and more importantly it is against the spirit in which MOD7 was developed. Real World Interfaces is a one person business dedicated to getting the most from musical instruments. I spend a lot of time researching new ideas, and keeping in touch with other musicians and recent developments.

MOD7.1 has a low price in the hope that this will discourage all but the most unreasonable copiers, and that the development effort will be repaid by many small sales rather than a few few big ones. For the forseeable future, nobody else is authorised to supply the MOD7.1 update, and you should be wary of anyone trying to sell you a pirate copy.

Each MOD7.1 has the owners name and address in the display at power on. This information is encoded and is not easily changed by someone with an EPROM programmer. If you wish to sell your DX7, with the MOD7.1 update, I can supply you with a new chip with the new owners name.

If your DX7 is stolen, you should contact me, and the Yamaha service department on 03-699-2388. For security you should record the DX7's serial number and engrave on the back of the instrument the first letter of your state, and your driving licence number. This enables police in all states to identify stolen property.

BUGS AND APPARENT MALFUNCTIONS

WEIRD BEHAVIOR IN GENERAL

I often get phone calls from people whose MIDI equipment is exibiting wierd behavior patterns. Although I will continue to support people who are using equipment I have modified, I am not in a position to give advice on equipment I have not had anything to do with. If you have trouble with your MIDI setup, my advice to you is to :- THINK, DIVIDE and CONQUER.

THINKING involves looking carefully at what MIDI signals are going where, what machines are receiving what messages, how they are interpreting them, what messages they may be sending to other machines via their THRU port or OUT port. Note that many sequencers can send what they receive from IN to the OUT port and may modify the messages and insert all sorts of things including All Notes Off commands into the data stream.

Be particularly wary of any scheme by which the DX7's output can go back to its input - for instance if this occurs, you hit one key and get two identical notes, or press the "+ button" once and transmit a second "+ button" command through your MIDI system only to receive it back again in the DX7. The result is that the value you are trying to change increments by 2 instead of 1.

DIVIDE - Your machine will probably function normally when it is entirely disconnected from all other devices, so start pulling out leads, turning off THRU facilities in sequencers until the problem goes away. Prove to yourself that a particular configuration is causing the problem, and try to figure out what kind of MIDI messages have been occurring. Swap keyboards and modules even if you believe they are not part of the problem - just to see if removing them does make a difference to your problem. Swap MIDI leads. Get rid of THRUs in the MIDI chain. Make the system as simple as possible and ultimately you will arrive at the simplest possible configuration which exhibits the weird behavior.

CONQUER - If you are a good detective you will be able to figure out what is happening, and perhaps find an alternative way of working. By investigating the problem yourself you have proved to yourself (and your equipment) that you are the BOSS.

DX7 DISPLAY STUCK ON YOUR NAME AND PHONE NUMBER

You have turned the machine on while it is in Split Mode 3 (local control off) and if you left it in Internal or Cartridge mode, then it will not display a voice name in place of your name, nor will it play sounds from the keyboard, or load a new voice when you press a button. This is all quite normal but can be disconcerting because your DX7 seems to be dead. Just change Split Mode in Function 13 to 0, 1 or 2.

STUCK NOTES

DX7s have an occasional problem of causing notes to hang in slave instruments. This only happens occasionally, and I have had difficulty finding the exact cause. MOD7.1 has some improvements to the suspected problem areas and I have had no reports of it causing stuck notes in slave modules.

DIFFICULTY SAVING EDITTED VOICE

When SPLIT MODE = 3 - local control off - you can edit the local sound of the DX7, but you will be unable to store it to memory. Change the split mode to 0, 1 or 2.

REPLACING YOUR OLD ROM CHIP

There may be some reason why you need to re-install you old ROM chip - for instance to play in Mono Mode. Simply remove the DX7s power cord from the wall, prise out the MOD7.1 EPROM with a screwdriver or two and re-insert the old chip.

You should then go through the function parameters starting with tuning, the pitch bend and portamento parameters and finally to the controller ranges and assignments. If your old ROM is a version 1.6, then these will not require adjustment, but if it is a different version, you will need to reset some or all of these parameters, since your old ROM stores them in different places to MOD7.1. When you re-install MOD7.1, got through the entire installation procedure to check that all function and new parameters have been set correctly.

Your old ROM will not support any new memory banks I have installed in your DX7 - internal memory will be bank 0. The new features of the + voice will not be provided by your old ROM, and + voices will generally sound horrible because of the LFO settings, or operator output levels in the 1 to 15 range. Likewise the # voice will just sound weird.

SOUND QUALITY IMPROVEMENTS - DAC MODS

HOW THE DAC MODS WORK

This is a set of hardware modifications I can do to the DX7, TX7 or TX816, which improves the performance of the Digital to Analog Converter (DAC) system and are hence also called the DAC Mods. These modifications and MOD7.1 are independent of each other, but there are certain MOD7.1 features which only work properly when the DAC mods have been done.

In a standard DX7, the OPS chip produces a separate number for each of the 16 sound channels. The number represents a + or - voltage for the waveform of the note currently being played on that sound channel. The OPS chip calculates an operator every 0.2 usec (1 / 5,000,000 of a second) and puts out a number for one of the 16 sound channels every 1.2 usec (a usec is one millionth of a second). The OPS chip therefore calculates 6 operators and puts out one note sample in the time it takes a Jumbo Jet to fly 3mm. The OPS chip calculates all 16 sound channel outputs every 20.4 usec for a sampling rate of 49.096 kHz.

For each sound channel, the OPS chip puts out a 12 bit number and a one of 4 divide factor. The DAC circuitry consists of a 12 bit DAC which produces a current. A first amplifier turns this current into a voltage which is sent into a voltage divider and analog switch system which selects the DAC voltage directly or thè DAC voltage divided by 2, 4 or 8. The divided values are used only when the waveform is close to 0 and gives finer resolution at low volumes as the sound decays. The selected voltage is buffered by a second amplifier and sampled for 0.2 usec into a capacitor. Consequently the DAC, amplifiers and divider/switch have only 1usec to settle from the previous sound channels voltage to the new voltage.

In analog electronics, 1usec is a very short time and so this is a daunting task. In the first DX7s the peak to peak voltage swing of the system was set at about 3.5 volts. There were intermodulation distortion problems between loud notes in adjacent sound channels, as the amplifiers could not slew and settle from one extreme of the 3.5 volt range to the other in the 1 usec available. This was rarely a problem musically but the design was changed to further restrict the voltage range to 2 volts. This fixed the intermodulation problem but further reduced the signal to noise ratio - most of the noise is made in the filters which follow the DAC section.

SIGNAL TO BACKGROUND NOISE RATIO, BUZZING AND ADJUSTMENT

The main part of the DAC Mods involves replacing the amplifiers and feedback networks with a much snappier (and quite unusual) design so that the system can slew and settle a 13 volt range in about 0.5 usec. Consequently the signal level through the DAC and filter systems can be much higher than a in a standard DX7.

The mods also eliminate a source of buzzing, which is most objectionable when a bass note decays. There is still noise and the occasioinal whistle "within" the sound - this noise is a function of the sinewave lookup table and other digital processes inside the OPS chip. The DX7-II which has different EGS and OPS chips, and a totally different DAC system has exactly the same noises "within" the sound as the original DX7. The DX7-II has about 4db more signal to background noise than most original DX7s. Original DX7s with the DAC mods are 8 to 10 db quieter than a DX7-II.

So the most important feature of the DAC mods for the DX7, TX7 or TX816 is that the signal to background noise ratio is improved by around 14 db (10 db for to early DX7s). The elimination of the buzzing distortion makes bass sounds much more usable. These improvements are achieved without filtering or any change in the frequency response of the system.

With the soft clip circuitry discussed below, the DAC mods have become slightly temperature sensitive, and may require adjustment at extremes of temperature to acheive the lowest possible level of buzzing at the end of a smoothly decaying note. To do this, load the DAC TEST Q voice and play it around C2 while you have the DX7's front panel opened up. Beware of live wires at the right end of the instrument. You can use a fine screwdriver to adjust trimpot VR7 for minimum buzz. VR7 located to the left of a green LED which is part of the soft clip circuitry of the DAC mods. I have found that the ideal adjustment when hot is slightly anticlockwise of the ideal cold setting. Once again beware of the 240 volts at the right end of the machine.

There are two addtional features of the DAC mods for the DX7 which are of particular importance when MOD7.1 is installed.

HIGH OPERATOR OUTPUT LEVELS

In a + voice with the operator output level set a 15, no keyboard level scaling or velocity sensitivity, and EG levels set to 99, an operator will produce an output about twice the level as it would with the usual maximum output level of 99. If this operator is OP 1 in ALG 16, 17 or 18, then the DAC system will attempt to produce a signal twice as high as it normally does. Similarly if two operators are set to produce their new double signal level, and they are the two operators which are producing sound (OPs 1 and 3 ALG 1) then when both operators are at the peak of their positive, or both at the peak of their negative waveforms, then their total will be twice that normally possible on a DX7.

An early DX7 will distort at the peaks of such a waveform, and will certainly experience intermodulation between notes on adjacent sound channels. A more recent DX7 will probably experience these troubles although to a lesser extent. Notes are allocated to sound channels in such a way that new notes are put onto sound channels which are least likely to be making a sound at present, however if you were playing lots of notes, then unpleasant intermodulation distortion would be inevitable. I suspect that higher output levels for operators on the bottom line of algorithms will produce unsatisfactory results on DX7s without the DAC mods.

When these higher output levels are generated on a DX7 which I have previosly done the DAC mods on (previous to September 1987), there will be a hard clipping of the peaks of the waveforms and very little or no intermodulation between notes on adjacent sound channels. The hard clipping gives a harsh fuzz box type sound to the very high output sounds. Since the clipping is on each note, rather than on the sum of several notes (as it is when a guitar chord is played into a fuzz box) each note of a chord sounds harsh and gutsy without the whole chord sounding mashed up.

DAC mods done after September 1987 have special circuitry to provide soft clipping for output levels above the normal maximum. The normal maximum levels are converted linearly over an 8.2 volt range, and beyond that range, the gain is reduced so that a 15 output level (which would try to reach a 16.4 volt range) is restricted to a maximum of about 13 volts. This is the absolute maximum range that the amplifiers and analog switches can handle.

This soft distortion never results in harsh clipping, and the sound is like that of a valve guitar amp driven too hard. I particularly recommend making + voices using ALG 16, 17 and 18, where OP1 is a low fixed frequency - say 0.4 Hz, and has no key velocity sensitivity. OP1 should have its output set to 15 and EG levels 1, 2 and 3 set to 99. The other operators provide the audio modulation of OP1 and can be made velocity sensitive and have decaying envelopes. The interactions of the other operators attempts to modulate OP1, and the soft distortion of that result produces a complexity and strength which I believe to be unique and highly desirable for hard hitting sounds.

SMOOTH CONTROL OF VOLUME

The standard DX7 has a crude 3 bit (8 step) DAC to provide a volume voltage for the instrument. The available steps of voltage are very coarse - each step quieter halves the voltage. This voltage is used to set the reference current of the main DAC, which directly controls the output of the entire DAC system. The trouble is that the next step quieter from maximum is half volume, without any reduction in the background noise (mainly caused by the filter which follows the DAC).

The standard DX7 receives a control change 7 as a volume command. The control change would typically be sent from a sequencer when you want to fade down the DX7, or compensate for variations in voice volumes. Either of the two problems with the standard DX7 - the coarseness of control, or the reduction in signal to noise ratio, would make the system unusable, and in fact it is used very rarely indeed.

The TX7 uses a 6 bit DAC (64 steps) to drive a VCA chip after the filters and so achieves a finer control of volume while cutting both signal and noise at lower volumes.

The TX816 uses a 7 bit (128 step) DAC to drive a LED - Light Dependant Resistor (LDR) combination after the filter. This is the ultimate system since the 7 bit DAC makes full use of the 7 bits of MIDI controller 7 volume data (128 possible levels) and the LDR is the best way of controlling volume - there is no distortion and no added noise.

The DX7-II is similar to the TX7 except that the volume slider also controls the VCAs. I suspect that much of the background noise in the DX7-II comes from these VCAs.

The DAC mods for the DX7 fix the reference voltage of the DAC, and use the output of the small 3 bit DAC to drive the foot volume pedal circuit when the volume pedal is not used. In the DX7 there is a LED/LDR combination after the filter system which is normally used by the foot volume pedal to control the final volume. Normally with no foot volume pedal plugged in, the LED/LDR is turned full on, and there the sound goes straight through. With the DAC mods the 3 bit DAC drives the LDR/LED and gives noise free reductions in signal as well as background noise.

After September 1987 the DAC mods include a 1 uf capacitor to smooth the output of the 3 bit DAC, because MOD7.1 switches continuously between two levels to achieve finer than 8 steps of volume control.

The 1uf capacitor is reasonably easy to install but the work should be done only by an experienced technician. Use a 1uf tantalum or aluminium electrolytic - make sure you know which lead is positive. The caps I supply have the positive lead marked red. Remove the DX7's power cord from the socket, open up the machine and locate IC 43 on the main board - it is an 8 pin DIP behind the lowest D# key. Immediately to the left of IC43 is a 0.1 uf capacitor. The new cap must be soldered in parallel or in place of this cap - it may be easiest to cut the front lead of the cap and remove the cap and its rear lead from the board as you heat up the rear lead's solder joint. The negative lead of the cap goes to ground - nearer the keyboard, and the positive goes to the track which runs to the 150K.

To test the system, close and power up the DX7, select an organ type voice, or INIT VOICE, and set VOLUME EN = 1. If the voice is not already a + voice, use Function 10 to make it so, and edit the voice parameter that used to be LFO Pitch Mod Sensitivity. This is now called VOICE VOL, and has 8 values between 0 and 7.

You can halve the capacitor value to 0.47 uf if you want faster volume changes, but you may hear slight volume fluctuations at certain volumes if you set SLOW TIMER = 2. You can double or triple the capacitor size for smoother volume changes, and this may be an advantage where you want to do slow DX7 fades under control of your sequencer. This capacitor does not affect volume response to the foot volume pedal. If you are using a WX7 Wind MIDI controller, please contact me because there are a number of problems in achieving the ideal response.

DAC mods done after September 1987 already have this 1uf capacitor installed. If your DX7 has the DAC mods from an earlier date, you should still install the capacitor if you want to use MIDI volume or voice volume with MOD7.1. The voice and MIDI volume system has no effect on DAC modified DX7s when the foot volume pedal is plugged in.

If your DX7 does not have the DAC mods, you should still install the capacitor if you want to use MIDI volume or voice volume with MOD7.1. Although lower volumes will reduce signal level without reducing background noise, the feature may still be useful for trimming some of the really loud voices which can give live sound mixers a headache.

MOD7.1 continuously looks at the most recently received MIDI volume, and if VOLUME EN = 1, multiplies the the voice volume (See page 10 for the two ways this can be stored in a voice). This number is reduced to 6 bits - 64 possibilities and used to control the 3 bit DAC level at each of 8 concecutive timer cycles. The lowest 8 possibilities are the same as the next lowest 8, and you should not expect the volume to fall linearly to nothing.

Whenever you look at or change the VOLUME EN parameter, or press the panic button, the most recently received MIDI volume is discarded, and 127 (maximum) is put in its place.

The foot volume pedal of the DX7 cannot be seen by the computer system and so has no connection with MIDI. With MOD7.1 you can use the data entry slider to write controller 7 changes into your sequencer, which MOD7.1 will receive as MIDI volume changes. When a pedal is plugged into the foot volume socket of a DX7, the pedal controls the volume, and MIDI volume and voice volume have no effect.

BATTERY VOLTAGE WITH 16 BANKS OF INTERNAL MEMORY

If your DX7 has the 16 internal banks of memory, then the battery voltage will be different from what it was before. Previously a 3.0 volt Lithium cell powered the memory. The old memory chips drew effectively no current, and the non-rechargable Lithium cell would last for years. Now there is a large Lithium battery which has a very large capacity and a self discharge rate below 1% per year. The 16 banks memory system draws about 0.000002 Amps and so the battery should last for at least 10 years. If the voltage drops below 2.7 volts, then the battery could be near the end of its life.

MIDI CONTROLLERS

A MIDI controller message consists of 3 bytes - 3 separate 8 bit numbers. For instance if your DX7 is transmiting on channel 2, and you move the mod wheel to a halfway position, the DX7 will transmit the following three bytes:-

10110001	Control change, channel 2
00000001	Controller number 1 (Mod wheel).
01000000	The new value is 64 - halfway to the the maximum of 127.

There are 128 possible controller numbers (0 to 127), and 128 possible values they can be set to. The original MIDI specification defined some of these conrtollers as having special functions, and more recently some more numbers have been given special functions which conform with the DX7.

Now that your DX7 can be made to transmit the data entry slider position on any controller number from 0 to 99, you may be interested to know what controllers do what. The controller number functions of instruments are listed on their MIDI implementation charts.

Pitch bend does not use the controller system - it has its own MIDI status byte.

CONTROLLER 1 MOD WHEEL

The original MIDI spec specifies this assignments and most synths conform to it. Certainly all the Yamaha instruments do do. The CZ5000 does, but the CZ101/CZ1000 uses it for vibrato on and off.

CONTROLLER 2 BREATH CONTROL

All Yamaha instruments conform to this. Most non Yamaha instruments do not have a breath control function.

CONTROLLER 3 AFTERTOUCH

Yamaha keyboards and modules conform to this. The DX21 does not because it has no aftertouch sensor.

CONTROLLER 4 FOOT CONTROLLER

Yamaha keyboards and modules conform to this. The DX21 does not because it has no foot controller.

CONTROLLER 5 PORTAMENTO TIME

Yamaha keyboards and modules and Casio CZ instruments conform to this.

CONTROLLER 6 DATA ENTRY SLIDER

Yamaha keyboards and modules conform to this. Casio CZ instruments receive (but do not transmit it) as a tuning value. The RX11 sends its data entry slider on controller 6.

CONTROLLER 7 VOLUME

The DX7 and other Yamaha keyboards and modules receive this. The DX21 and DX7-II transmit it as well. The DX7s foot volume pedal does NOT transmit to MIDI.

CONTROLLER 10 PAN

The MT32 and many other modules receive this.

CONTROLLER 64 SUSTAIN PEDAL

0 = OFF, 127 = ON. Yamaha keyboards and modules conform to this, as does the CZ5000 but not the CZ101/CZ1000.

CONTROLLER 65 PORTAMENTO ON/OFF

0 = OFF, 127 = ON. Yamaha keyboards and modules conform to this, as do the CZ instruments.

CONTROLLER 66 SOSTENUTO PEDAL

DX7-II uses this.

CONTROLLER 67 SOFT

DX7-II uses this - I am not sure what it is for.

CONTROLLER 96 DATA ENTRY + BUTTON

Yamaha keyboards use this, as does the TX7 but not the TX816.

CONTROLLER 97 DATA ENTRY - BUTTON

Yamaha keyboards use this, as does the TX7 but not the TX816.

CONTROLLER 122 LOCAL CONTROL ON/OFF

0 = Normal mode - the keyboard makes sounds. 127 = Local control off. Yamaha keyboards do not seem to respond to this although it is in the MIDI spec. The CZ instruments do receive it.

CONTROLLER 123 ALL NOTES OFF

0 = turn off all notes. This is in the MIDI spec, but Yamaha keyboards ignore it. Most other instruments do receive it. MOD7.1 receives if ANOFF IN = 1.

CONTROLLER 124 OMNI MODE OFF

0 = Go back to receiving on only one channel. Turn off all notes. The TX7, TX816 and CZ instruments use it.

CONTROLLER 125 OMNI MODE ON

0 = OMNI on - receive on all channels. Turn off all notes. The TX7, TX816 and CZ instruments use it.

CONTROLLER 126 MONO MODE

0 = Select MONO MODE and turn off all notes. The standard DX7, TX7, TX816 and CZ instruments use this. The DX7 with MOD7.1 ignores it.

CONTROLLER 127 POLY MODE

0 = Select POLY MODE and turn off all notes. The standard DX7, TX7, TX816 and CZ instruments use this. The DX7 with MOD7.1 is always in POLY mode.

NOTE NUMBERS TO KEYBOARD KEYS

No.	KEY	
96	C6	Top key of DX7 and other 5 octave synths, but the DX7 will play above this from MIDI.
95	B5	
94	A#5	
93	A5	
92	G#5	
91	G5	
90	F#5	
89	F5	
88	E5	
87	D#5	
86	D5	
85	C#5	
84	C5	Top key of CZ-101 but it will play one more octave from MIDI.
83	B4	
82	A#4	
81	A4	
80	G#4	
79	G4	
78	F#4	
77	F4	
76	E4	
75	D#4	
74	D4	
73	C#4	
72	C4	
71	B3	
70	A#3	
69	A3	
68	G#3	
67	G3	
66	F#3	
65	F3	
64	E3	
63	D#3	
62	D3	
61	C#3	
60	C3	Middle C
59	B2	
58	A#2	
57	A2	
56	G#2	
55	G2	
54	F#2	
53	F2	
52	E2	
51	D#2	
50	D2	
49	C#2	
48	C2	
47	B1	
46	A#1	
45	A1	
44	G#1	
43	G1	
42	F#1	
41	F1	
40	E1	
39	D#1	
38	D1	
37	C#1	
36	C1	Lowest key on most keyboards but the DX7 will play below this from MIDI.