REAL WORLD INTERFACES

Musical Instrument Modifications by Robin Whittle

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MT32 MODIFICATIONS AND A GUIDE TO HOW THE MT32 WORKS

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PLEASE READ AT LEAST THIS

This user manual firstly describes the MT32 modifications in detail, and secondly gives you important background information on how the MT32 works. Please read the second section (pages 10 to 13) carefully so that you will have a clear understanding of the various MT32 internal issues which are ignored or glossed over in other documentation. Some of this information may look boring and unmusical, but most of it is essential to the proper operation of the machine. Please do not ask for technical assistance until you have read this entire manual.

At the time of writing, there are two people in North America who are licenced to carry out these modifications.

Gary Hewett Technical Magic - Ottawa (613) 596-9114

David Neely L.A. Custom Instruments - Los Angeles (818) 797-8529

John Conelly of Beaverton Digital Systems was licenced until June 1989 - if you have had any dealings with him please read the Beaverton section on page 15. If you are in any doubt as to who is currently licenced to do the mods, please make a quick call to 011-61-3-459-2889 and I will ring you back.

There are now two types of MT32. The new type has a headphone socket and has some ROM play demo songs built into it. I have not yet figured out the details of modifying these new MT32s, but hope to in the next 3 to 6 months. The sound quality improvement details below are relevant only to the original MT32.

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SOUND QUALITY IMPROVEMENT MODIFICATIONS

I have removed the whistling sound which is constantly in the background, and some of the continuous background hiss. This removes around 4db of continuous noise from the normal outputs. These changes do not involve filtering, or noise gating so there is no adverse effect on the sound quality.

The MT32 uses a 16 bit Digital to Analog Converter (DAC) to create the sound we hear. Few DACs are perfect and they all should have a trimpot to null out an error which occurs right in the middle of their range. The MT32 designers were too cheap/hurried/silly to install such a trimpot and so all MT32s to some extent have a graininess distortion which is particularly annoying as a sound decays to "silence". I add a trimpot circuit and when correctly adjusted, the graininess in the sound is reduced to a very low level. There will however be some noisiness to sounds made from the PCM waveforms since these are only 8 bit samples. Whistle tones which come with low frequencies are still audible but are generally quieter than before.

I have permanently reduced the mixing level of the Reverb signals so that the digital part of the Reverb system can be run at a higher signal level for a reverb level which is musically useful. This means that the maximum reverb level is reduced compared to a standard MT32, but this was so high that it would hardly ever be used. The standard MT32 has 50% reverb 50% direct signal, and my modifications change this to 18% reverb and 72% direct. Since the digital part of the Reverb section now can have a much higher signal level for a given level after being mixed, the resolution is improved, and the noisiness of the reverb is largely eliminated. If you feel you may need high levels of reverb, you could request that your MT32 be modified with a higher reverb mix level, but this will result in a greater reverb graininess and a slightly reduced output level for the main outputs. A better alternative would be to have the individual outputs installed so that the reverb signal could be sent to your mixer and mixed at any level you desire.

Below is a comparison of a standard and modified MT32. Noise above 300 Hz was measured on an un-weighted non RMS meter. Output and noise figures are measured at the right normal output and the right "reverb send" output of a modified MT32 with individual outputs.

	Standard MT32 Right output	Modified MT32 Right output	Modified MT32 Rev Send out
Output level compared to standard MT32	0	+0.3	-0.6
Continuous background noise above 300 Hz	-83 dbm	-87 dbm	-91 dbm
Level at which soft clipping occurs		+7.3 dbm	+6.4 dbm
Level at which gross distortion occurs	+2 dbm	Does not occur in modified MT32	
Ratio of maximum signal to background noise	85 db	94 db	97 db

The linearity improvement is hard to quantify, and some standard MT32s are worse than others. It is audible as reduced distortion and noise at the end of a decaying sound. This combined with the reduced reverb mixing level makes the reverb sound very pleasant indeed.

In the standard MT32 if the LA chip tries to go beyond + - 16,384 voltage steps of its range the system overloads badly and creates a terrible clicking distortion. In the modified machine this cannot happen, and the DAC linearly converts the LA chip's entire + - 32,768 range. The LA chip soft clips at these limits. A similar clicking distortion occurs if the filter resonance and partial output level are too high - this is unrelated to the mods.

BATTERY BACKUP MEMORY

Normally the MT32's memory is not backed up when the power is turned off. After a great deal of investigation into the internal software, and the installation of a Lithium battery. I have achieved complete retention of all data, including drum assignments, patch assignments, 64 timbre memory, tuning, reverb and the temporary patch and timbre areas for each part. Therefore the MT32 can be turned off and on without any change in behavior. My MT32 erases the first two characters of the first memory timbre's name when it is turned off, but this does not affect the sound in any way.

The BR2/3A Lithium battery should last at least 10 years, however I advise checking the battery voltage after about five years. It is clearly visible inside the machine and should measure 2.9 volts or above.

FRONT PANEL REVERB CONTROL

There are now 50 reverb settings accessable from the front panel instead of the 9 in the standard machine. As before, hold "Master Volume" and press "Volume". Adjust the setting with the volume knob. The reverb system is actually capable of 4 types of operation with 8 levels and 8 times. The 50 modes represent a good selection of the 255 possible reverb settings - there are 206 more but they all fall inbetween the settings I have provided. The alternate reverb modes are a separate issue and are described on page 7.

0	No reverb.
1-9	Room reverbs in ascending times and volumes.
10-19	Hall reverbs in ascending times and volumes.
20-29	Plate reverbs in ascending times and volumes.
30-50	Delays in ascending times and volumes.

FRONT PANEL SELECTION OF THE MEMORY AND RHYTHM TIMBRES

With the M9 modified software, the usual Sound Group and Sound method of selecting ROM timbres has been extended to include the 64 M RAM timbres and the 30 R rhythm timbres. The R timbres are fixed in ROM like the 64 A and 64 B timbres which you normally select via the front panel, but the 64 M timbres can be your own timbres written using an editting program.

In a standard MT32 the last sound group is Effects, but now there are 10 sound groups beyond that which give you access to the M and R timbres - mainly in groups of ten. For instance if you wanted to load M27 into a part, then press the "Sound Group" button and turn the knob until you see the group named "M20-M29", then press the "Sound" button and turn the knob until you see the timbre's name appear in the display.

CONTROLLING INTERNAL PARAMETERS WITH SPECIAL CONTROL CHANGES

STANDARD MT32 CONTROL CHANGES

These control changes only affect the parts which receive them.

1	0-127	Modulation Wheel
7	0-127	Volume
10	0-127	Pan
11	0-127	Expression - similar to volume

SPECIAL CONTROL CHANGES

A control change is a MIDI event which a sequencer or master keyboard can generate. It has three items of information in it - the MIDI channel, the controller number and the value. Some controller numbers have industry standard functions such as controller number 6 which is the data entry slider (except in Casio CZ101s where it is tuning). Most sequencers allow you to insert control changes into the sequence at any point, and many good keyboards enable you to make a slider transmit on any controller number you like. A control change is like a note on or off event in that it is on a particular MIDI channel. For the normal control changes and the new control changes 12 to 16, you need to send them on a channel which is being received by the part you wish to affect. For instance in an MT32 set up like the Data Areas diagram on the back page, if you wanted to set a one octave pitch bend range in part 2, then on MIDI channel 3 you would send a control change 14 with a value of 12.

The special control changes enable you to change many parameters, but do not allow you to see what the parameter's value was. When a change has occured, the new value is displayed on the right of the LCD display. This may disrupt the display but it does not upset what you may be doing with the front panel. When the new controller numbers are used, the received value is limited to the allowed range, before being written to memory and displayed. Therefore you do not need to worry about sending values outside the allowed range. Out of range values are limited to the nearest proper value.

Controllers 12 to 16, like the standard controllers above only affect the parts which receive them. The controllers 17 to 33 will do their job no matter which part receives them. You must however send them on a channel which at least one part is assigned to.

A typical application may be to set parts 1 and 2 both to receive on channel 1, and to send a patch change to both of them on channel 1 so they will both be playing the same sound from the same MIDI channel. You could then set part 2 to receive on channel 2, and send part 2 a detune value and pan it hard right. You could then send a hard left pan to part 1 on channel 1, and then set part 2 to receive on channel 1 again. Now notes sent to the MT32 on channel 1 will be played with the same sound, with detuned versions coming from left and right outputs. These control changes could be sent from a master keyboard or a sequencer.

CONTROL CHANGES WHICH AFFECT THE PART WHICH RECEIVES THEM

CONTROLLER NUMBER	RANGE	FUNCTION
12	0-48	Keyshift - 24 is normal
13	0-100	Fine Tune - 50 is normal
14	0-24	Pitch bend range
15	0-3	Assign mode - I am not exactly sure what this does
16	0-1	1 means assign this part to reverb

These five patch changes enable you to alter the values of these five parameters from your sequencer or master keyboard. Whenever you send a patch change to a part, these five parameters are loaded with values copied from the patch table entry which is pointed to by the patch change number. So it is no good setting a part up with particular keyshift, reverb on/off etc and then sending a patch change to load in the timbre you want - you should do it the other way around. Send the patch change to load in the desired timbre, and then send control changes to set these parameters the way you want them.

CONTROL CHANGES WHICH AFFECT THE MACHINE NO MATTER WHICH PART RECEIVES THEM

REVERB AND MIDI RECEIVE CHANNEL PARAMETERS

CONTROLLER NUMBER	RANGE	FUNCTION
17	0-3	Reverb mode
18	0-7	Reverb time
19	0-7	Reverb level
21	0-16	MIDI receive chan for part 1
22	0-16	MIDI receive chan for part 2
23	0-16	MIDI receive chan for part 3
24	0-16	MIDI receive chan for part 4
25	0-16	MIDI receive chan for part 5
26	0-16	MIDI receive chan for part 6
27	0-16	MIDI receive chan for part 7
28	0-16	MIDI receive chan for part 8
29	0-16	MIDI receive chan for Rhythm part 0 means this part is turned off.

It does not matter which channel you send the above control changes on provided the MT32 is receiving on that channel with one or more of its parts (including the Rhythm part). If you are sending several control changes 21 to 29, you will need to be careful that the changes you make to the MIDI receive channels do not result in subsequent control changes being ignored.

CONTROL CHANGES FOR SETTING UP THE DRUM TABLE

CONTROLLER NUMBER	RANGE	FUNCTION
30	24-87	Drum note number to change with controllers 31-34
31	0-94	Timbre number - 0 = off 1-64 = M memory timbres 65-94 = R rhythm timbres
32	0-100	Output level
33	0-14	Pan
34	0-1	1 = sound assigned to reverb

These control changes can be sent on any channel provided that at least one part of the MT32 (including the Rhythm part) is receiving that channel. In the "Data Areas" diagram you can see that the drum table contains 64 entries for each note number between 24 and 87. When a note on event is received by the rhythm part, the MT32 looks into the drum table for the 4 byte entry for that particular note. It plays the timbre specified there at the appropriate volume and pan, and sends it to the reverb system if the reverb parameter is set to 1.

To change the parameters of a particular note number, first of all send a control change 30 with a value which is the number of the note you wish to alter. Thereafter, the control changes 31 to 34 will change the four parameters of that note number.

Timbre numbers 65 to 94 select timbres from the R bank. These timbres are all written in a way that their tuning is not affected by what note they are played from. With an editting system you can create a timbre in one of the parts and write it to the M bank in battery backed up RAM. If you wish to play it from the drum table, you may wish to edit the timbre in such a way that the pitch key follow parameter is set to 0 so that you can put it anywhere on

the drum table without affecting its pitch. You may also wish to set the envelope mode to no-sustain so that the note will sound its full length even with the very short note events which are often used to drive drum sounds.

In the standard MT32, the drum table is written with default settings from ROM every time the machine is turned on. In the modified MT32 the drum table will only be loaded with default values when you do a master reset - hold "Master Volume" and press "Rhythm", then press "1".

In the default drum table settings, all entries have 100 for volume and 1 for reverb - meaning that all sounds are assigned to reverb. The pans are different for each entry and the timbre numbers are as shown below.

Note		Timbre	Note		Timbre	Note		Timbre	Note		Timbre	Note		Timbre	Note		Timbre
C	24	0	36		65	48		67	60		83	72		90	84		0
C#	25	0	37		75	49		73	61		84	73		93	85		0
D	26	0	38		66	50		67	62		78	74		0	86		0
D#	27	0	39		76	51		74	63		79	75		88	87		0
E	28	0	40		70	52		0	64		80	76		0			
F	29	0	41		69	53		0	65		81	77		0			
F#	30	0	42		71	54		87	66		82	78		0			
G	31	0	43		69	55		0	67		85	79		0			
G#	32	0	44		94	56		77	68		86	80		0			
A	33	0	45		68	57		0	69		92	81		0			
A#	34	0	46		72	58		0	70		89	82		0			
B	35	65	47		68	59		0	71		91	83		0			

Here are the 30 timbres in the R bank in ROM, together with their number within the bank (1 to 30) and the number which would need to be written into the drum table to select them (65 to 94).

1	65	Acou BD	11	75	Rim Shot	21	85	Hi Agogo
2	66	Acou SD	12	76	Hand Clap	22	86	Lo Agogo
3	67	Acou HiTom	13	77	Cowbell	23	87	Tambourine
4	68	AcouMidTom	14	78	Mt HiConga	24	88	Claves
5	69	AcouLowTom	15	79	High Conga	25	89	Maracas
6	70	Elec SD	16	80	Low Conga	26	90	SmbaWhis L
7	71	Clsd HiHat	17	81	Hi Timbale	27	91	SmbaWhis S
8	72	OpenHiHat1	18	82	Low Timbale	28	92	Cabasa
9	73	Crash Cym	19	83	High Bongo	29	93	Quijada
10	74	Ride Cym	20	84	Low Bongo	30	94	OpenHiHat2

INDIVIDUAL OUTPUTS

It is impossible to provide individual outputs for each part, however since there are six sample and hold circuits in the MT32 (see the hardware diagram), it is feasible to provide four additional outputs, so that you have direct access to all six signals. The individual outputs are not much use to you unless you can control whether a timbre has reverb selected or not. Normally you can only do this if you have access to an MT32 editor program running on a computer. Now with the new control change reception facility (see previous section) you can set each part and each individual drum note to send its sound to reverb or not to reverb without the need for an editor program.

If you look at the hardware block diagram on the last page, you will see three sample and hold circuits producing three analog signals for each side - left and right. Normally the three are simply mixed together, but I have provided individual outputs for two of them, so that when an individual output is used, that signal is removed from the main mix. The three signals are :-

DIRECT — When you specify that a timbre is not to have reverb, that timbre's sounds are sent to this sample and hold. With pan = 0, the sounds are sent to both Left and Right DIRECTS. When panned to the extreme left, the sound that would have gone to the right is added to the sound already being sent to the left. I have not provided an individual output for this signal, but if you insert plugs into the individual outputs for the two signals below, then only the DIRECT signal will be present at the main output.

REV SEND When you specify that a timbre IS to have reverb, that timbre's sounds are sent to this sample and hold. At the same time the reverb system adds together the numbers which make this signal and uses the total as the input to the reverb process. This signal has an individual output so that if you plug a lead into this socket, you will get the sounds you want to be reverberated, but without the reverb. These sounds will then no longer appear at the main output.

Note that you cannot put a signal into this socket and expect it to be reverberated.

REV OUTPUT This is the signal from the reverb system and consists entirely of reverberated or delayed sounds. If you plug into this individual output, then you can mix this signal externally or ignore it. The reverb signal will not appear at the main output if something is plugged into this individual output.

These individual outputs - four 1/4 inch phone sockets at the rear of the MT32 - mean that you can send drum and keyboard timbres to four separate outputs. If your sound is panned hard left and reverb is off, it will appear only at the left main output if the left REV SEND and left REV RETURN outputs are in use. If you pan it hard left and select reverb on, then it will appear only at the left REV SEND output. Likewise for the right channel.

For the drum part, the reverb and pan settings for each drum note are controlled by the drum table which is stored in the MT32's memory. This information can be altered with an editting program or via the new control changes 30 to 34.

For Each of the 8 instrument parts, the panning is controlled by a byte in the MT32's memory for that part. You can change the pan by sending a control change 10 to that part, or set it by using an editting program. The reverb on/off for each part can also be controlled by an editting program, and can now be changed with control change 16.

The individual output sockets do not have mute circuits and so will produce bumps and clicks as the power is turned on and off. Beware of this if the individual outputs are driving a large sound system.

Each of the four individual output sockets has a 6.8K output resistor, effectively the same output impedance as the normal outputs. This is so that you can connect them electrically together and they will mix evenly. If you connect the Right "Rev Send" (top) socket to the Right "Rev Output" (lower) socket the result will be 50% direct and 50% reverb sound. If you wanted to use the normal outputs for two individual sounds, and plugged them into two channels of your mixer, and you only had two mixer channels left, you could make up a special lead to connect the two left individual outputs togther and send them to a mixer channel and make a similar lead for the right sockets. If you wanted to reduce the mixing level of the reverb signal - and so have lower graininess and maximum reverb level - you could install a 22K resistor in each of the plugs which go to the "Rev Ouptut" sockets.

ALTERNATE REVERB MODES

The reverb chip in the MT32 is a special purpose digital processor which has its programs stored in an EPROM or ROM chip. The four reverb modes select four different sections of the ROM and in fact each section contains 16 separate programs, one of which is selected depending on the reverb level and time parameters. The reverb chip is entirely controlled by the programs in this ROM chip, and so by installing an EPROM with different programs, I can change the MT32 reverb modes.

In a standard MT32 there are four modes :-

1	ROOM	)
2	HALL	) All three are relatively similar to each other.
3	PLATE	)
4	DELAY	Stereo left-right-left-right echo.

In this optional mod I install a new EPROM which retains the MT32's Hall reverb, but replaces the other three.

1 MEDIUM ROOM - a warm reverb which is shorter than the HALL. From the D110.

2 HALL - original MT32 Hall reverb.

3 BRIGHT PLATE - a very bright long reverb, similar to the D110 plate reverb, but smoother - without the "cyclic ringing". I discovered this program in the half of the MT32 ROM which is never accessed!

4 DELAY 3 - similar to the MT32's Delay, but has a better selection of delay times - most of the MT32 Delays are too short. From the D110.

Since the alternate modes replace the original modes, you loose the original Room, Plate and Delay settings, but gain two more diverse reverbs and a more usable Delay. The four modes are accessable from an editting program in the normal way.

MODE	1	2	3	4
Control change 17	0	1	2	3
ORIGINAL MT32	ROOM	HALL	PLATE	DELAY
ALTERNATE MODES	MEDIUM ROOM	HALL	BRIGHT PLATE	DELAY 3
FRONT PANEL SETTINGS	1-9	10-19	20-29	30-50

WIERD BEHAVIOR

Occasionally an MT32 will exhibit weird behavior - for reasons which cannot always be understood or replicated. There must be some remaining bugs in the software which cause missing or quiet notes when a large amount of MIDI information is sent to the MT32 - even though the MT32 may be playing little of it, the machine seems to make more mistakes if it has to wade through a heavy stream of MIDI.

If your machine does not seem to be having properly in general, you should turn it off and disconnect it from all MIDI devices, except a simple keyboard to drive it, and then turn it on again. If you still experience difficulties then the only approach is to reset all memory variables. This is what an un-modified MT32 does every time the power is turned on, and it will erase any data you have in the M timbre memory, the patch table, the drum table and the timbres and MIDI channel assignments of the 8 parts.

To reset the machine - press and hold "Master Volume" and press "Rhythm", release these buttons and press "1".

The MT32 seems to make up its own mind whether a particular partial will have its waveform produced normally or inverted. If you play a single partial and look at the waveform on an oscilloscope, you will notice that very often, the waveform is upside down compared to its normal polarity. This is not a problem in itself because our ears cannot generally tell the difference. This unpredictable behaviour becomes a nuisance if we create a timbre with a pair of partials which make waveforms which are identical apart from a slight detune. Normally the two waveforms will be the same polarity and make a louder sound until the detune separates them. However if one partial is inverted, then the two cancel out and you hear virtually nothing until the detune takes effect.

If you experience clicking sounds after the Sound Improvement Modifications have been done, then the cause is probably a combination of high filter resonance and high envelope and output levels in at least one of the partials. The filter section of the LA chip can be overloaded and "wrap around" to produce unpleasant distortion or clicks. The solution is to reduce the envelope or output level, or reduce the resonance of the TVF.

Reducing the volume or expression (control changes 7 and 11) while holding notes on, will sometimes leave a note with a high volume. Sometimes it is possible to create a partial where for a certain range of the keyboard the filter seems to suddenly disappear. Both these are obscure bugs in the original MT32 software.

THE INTERNAL EDITTING SYSTEM

This is currently under development and will enable reading and writing of all internal data via the front panel buttons and knob. It will also be possible to move timbres around the place, and perhaps send and receive system exclusive dumps of internal data so that this may be saved on a sequencer. If there is a way of doing alternate tuning systems then I will tackle that as well. You will be able to install the editting system in an MT32 that I have previously modified, without the need to send it away.

The editting system will not be as conveninent as a screen based editting program when it comes to changing envelopes. Some editting programs (Dr T and Roland at least) do not actually read data from the MT32, so there is no easy way of reading your MT32's data into an edit program. It will however be very convenient since it is always there.

The internal editting system will come with a comprehensive manual.

SOFTWARE VERSIONS

The early MT32s came with various internal software versions. My modified software is based on the version which Roland finally settled on. I have improved my software in several different stages. My M8 software did not have the selection of M and R timbres from the front panel. The previous version did not have the new control changes.

There are actually three versions of my M9 software. The original version had a bug which caused the Synth 2 sound group to start at the wrong place with the result that you could not select Square Wave from the front panel. This was fixed in the second version of M9. In these versions and in M8, I had replaced the "Master Volume" & "5" function with a message saying "Edit Mode under development". This meant that it was impossible to change the MIDI receive channels to 1-8 from the front panel. This would have been a serious nuisance to some users, and so in the third version of M9 I have restored the original "Channel 1 to 8" function.

THE LA SYNTHESIS FAMILIES OF INSTRUMENTS - D110/D20/D10 MODIFICATIONS

The D50 keyboard and D550 rackmount module are the first family of LA products from Roland. They can be set up to play two timbres at once. There is a digital EQ and chorus system and an elaborate digital reverb system.

The MT32 is the first member of the second family. It is more flexible than the D50/550, but was intended to be a cheap consumer product without battery backup, editting or rack mounts. Corners were cut in the DAC circuitry, there is no EQ or chorus and the reverb is a simpler system. The PCM samples in ROM are different from the D50, and the timbre data is similar to the D50 but different in detail. D50 voices cannot be played by the MT32. There are now various other MT32 like products - two white boxes intended to look good next to gleaming white computers, and a IBM plugin card which essentially contains an MT32 and an MPU-401 MIDI interface. I have not developed any mods for these machines yet - it is quite likely that I never will. These MT32 soundalikes, and the new version of the MT32 (with a headphone socket) all use an 8 bit CPU, so I would expect them to be significantly slower in responding to MIDI note events.

The D110 is a rackmount counterpart to the D10 and D20 keyboards, the three of which comprise the third family in the LA range. The D110 is what the MT32 really should have been - it has 4 extra mono outputs (with no reverb on the individual outs), battery backup, editting, and true rack mounting. If you are not using reverb then there are 6 individual mono outputs. Its waveform samples in ROM are different from the MT32, and its timbre data is incompatable with the D50 and MT32. The MT32 reverb system is used but has 8 programs rather than 4. The D110 has a RAM card slot and is not compatable with MT32 editting programs. I can improve the D110's and the D10's and D20's signal level by 6db and reduce its noise level by about 3db - this brings it up to the standard of the modified MT32. I can also make the D110's reverb return available from individual ouptuts 5 and 6. The D10 and D20 can have individual outputs just like those of the MT32 described on page XX.

The D110 has a slower computer than the MT32 and is a little slower at responding to note events - about 2.5 msec rather than 1.5 msec. The D10 and D20 use a 16 bit version so they should not be slow.

All these instruments are based on the Roland LA32 chip and are like different models of car built around the same chassis and motor, but with different bells and whistles. The D110 is probably the best module - but the MT32 is cheaper and faster.

HOW TO UNDERSTAND THE MT32 - EVEN IF YOU ARE A HUMAN BEING

The data areas of the MT32 are well designed but quite complicated, and are not explained in the MT32 manual. The MIDI spec gives some clues as to what is going on inside, and the documentation which comes with the editting programs attempts to explain the details but do not give you the big picture. Whether your mind is used to dealing with computer-type information or not, you are likely to find the MT32 very confusing at first, and the main reason for this is that nowhere is there a diagram to give you a bird's eye view of what is going on and how the various internal data areas of the MT32 relate to each other. What is required is some block diagrams to put all the worm's eye details into context.

The MT32 is marketed as a home product for use with the PR100 sequencer - it is intended to be sold to someone who likes to relax by playing a Roland electronic piano after a hard days work. It so happens that the MT32 can make a lot of great sounds, has MIDI access to all its internal data, and is suited to professional use in the studio and on stage. Consequently the MT32 has been bought by lots of working musicians, and not very many have ever been connected to a Roland piano. Judging by the earliest and latest serial numbers, over 180,000 MT32s have been sold, making it even more popular than the the original DX7 (over 140,000).

The full capabilities of an MT32 can only be used when you can edit all the internal data areas. Currently the only practical way to do this is to use an MT32 editing program. These are currently available for Atari ST, Amiga, Mac and IBM computers. The forthcoming internal editting system will enable you to read and write all the data stored in battery backed up RAM.

The standard MT32 does not have a single "System Exlusive Dump" of all its internal data, rather it has a system which enables an external device to change and read internal data one or several bytes at a time. In principle you can create your own system exclusive commands to do this (for instance on an MC500), but it is rather complicated and tedious.

HARDWARE - FOR ELECTRONIC BUFFS ONLY

You do not need to understand the MT32's hardware to make use of the machine, but I have included an explanation here for those who are interested. The "Data Areas" section which follows this section is however essential reading. Please refer to the diagrams on the last page of this guide.

The controlling CPU (Central Proccessing Unit) is an Intel 8096 - a relatively obscure microproccessor completely unrelated to the 8086 series found in IBM computers. It is a true 16 bit machine and although it is limited to a 64K address space, it is a very fast and well designed CPU. It contains 256 bytes of RAM/registers on the chip and an instruction prefetch queue, so many data manipulation instructions do not take up bus cycles. The I/O on chip includes serial (for MIDI), timers, a watchdog timer (to reset the CPU if it crashes), parallel I/O and an 8 bit analog to digital converter which reads the front panel pot. In this application the 8096 is significantly more powerful than an 8 Mhz 68000 would be.

There are 64 K bytes of ROM (Read Only Memory) half of which contains the program for the 8096 and the other half contains the ROM timbres and other preset data. 32 K bytes of RAM (Random Access Memory - Read/Write) are not normally battery backed up, and so are normally preloaded with data from ROM whenever the machine is turned on. In a battery backed up MT32, this does not occur and the RAM retains the 64 M timbres, the drum table, the patch table, the setup information and the 8 temporary timbre areas for the 8 parts.

The CPU (under the control of the program in ROM, the data in RAM and your MIDI input) controls the LA (Linear Arithmetic) chip which is actually calculating the numbers which make up the sound. The LA chip is a 7mm x 8mm chip with over 100,000 transistors in it. This big beautiful beast is a Roland custom chip and obviously the product of a major R&D (Research and Development) investment. You are welcome to look at an LA chip through my microscope. The LA chip is continuously calculating numbers, and produces four results every 32 usec (microseconds). These totals are calculated from 32 partials which it recalculates every 32

usec. Each partial can be either an oscillator - filter - "EG-VCA" type synthesizer process (all calculated with binary numbers) or it can be playing an 8 bit waveform from an external ROM. The ROM (or two ROMS in early MT32s) contain half a megabyte of 8 bit sampled PCM (Pulse Code Modulated) sounds, and although you can vary the pitch and volume envelopes of the PCM sounds you cannot filter them, or insert your own loop points.

Every sample cycle The LA chip produces four 16 bit numbers and these are converted into four different voltages by the DAC (Digital to Analog Converter). In the standard machine bit 14 is ignored Two of the numbers are the sum of the left and sum of the right sounds which have not been assigned to Reverb. These voltages (labelled Normal in the diagram) are sampled and held in two SH units. The other two numbers are the sum of the left and sum of the right sounds which have been assigned to reverb. These are converted to voltages and stored in another two sample and hold units, and while the LA chip is outputting these two numbers, the Reverb system reads the numbers, adds them together and uses the total as its input.

The Reverb system consists of a Roland custom chip with four reverb programs stored in a separate ROM. It uses four Dynamic RAM chips for temporary storage of sound data. After the LA chip has sent its numbers to the DAC, the Reverb system sends two numbers - left and right reverb return to the DAC and these are stored in two more SH units. The Reverb system is 16 bits wide for input and output and has 16 bit storage of sounds. Note that there is no analog to digital converter in the system, so you cannot plug external analog signals into the reverb system.

The outputs of the Sample and Hold units are mixed and filtered to produce left and right outputs. If I have installed individual outputs, there are four sockets which give you direct access to the Reverb Send and Reverb Out signals - each via a simple low pass filter. Plugging into an individual output removes that signal from the main mix.

An ideal 16 bit reverb system stores more than 16 bits in its RAM work area, and the system which is used in the D50 stores 24 - this gives finer detail at the tail end of the reverb sound.

THE DATA AREAS - RECOMMENDED READING FOR ALL MT32 OWNERS!

To understand the MT32 you need to understand what the data areas are, what is inside them and how they relate to each other. The accompanying diagram maps out the various areas. I will explain what they do and then give examples of how they work together.

Apart from the A, B and R timbre banks, all these areas are in RAM. This means that for any MT32 the information they contain can be changed, but that in a standard MT32, all will be lost when you turn the machine off. A standard MT32 will write default values from ROM into all the data areas when it is turned on - the M bank is loaded with a repeating sequence of 8 ROM timbres.

WHAT IS A PARTIAL ?

The LA sound producing chip can calculate 32 partials and combine them in various ways to produce the final sound that we hear. Each partial is a digital audio sound generating process which can be either an oscillator-filter type synth sound or it can play (without filtering) one of 128 fixed sampled sounds (some of which loop continuously). In both cases the pitch and volume can vary according to envelopes and other factors.

WHAT IS A TIMBRE ?

This is a body of data which specifies most of the details of how the MT32 will make sound when it receives a note event from MIDI. A timbre will specify that 1, 2, 3 or 4 partials be used to make the sound, specify exactly how each partial will calculate its numbers and specify how those partials will be combined to form the final output. Timbre means "characteristic quality of sound" and is pronounced not like "timber" but like "tamber" in "tambourine".

I will not explore timbres in detail here but it is worth mentioning that a timbre has two data areas. The first contains the timbre's name, and data on the mixing and mode of operation (S for Synth mode or P for PCM sample mode) of between 1 and 4 partials. The second

area of data includes between 1 and 4 partial specifications - each of 58 bytes specifying in detail how the partial is going to create sound.

For instance one timbre might specify how one partial should make a synth sound and how it should be ring modulated with a second partial that is producing another synth sound. Each time the MT32 plays a note using this timbre, it will use 2 of the 32 available partials in the LA chip. Some timbres use only one partial and others use up to 4 so the number of notes you can play at once depends on which timbres you are playing.

SETUP DATA

This is a small body of data which always affects the entire MT32. Master volume and master tune can be set from the front panel as can the Unit number. The Unit number is so that in a multi MT32 situation, a computer program can send system exclusive messages containing different unit numbers, and each MT32 will have a particular unit number and respond to only the system exclusives intended for it. The rhythm receive channel is normally 10 but can be reassigned with an editor or by sending control change 29. The reverb hardware can do 4 types of reverb - room, hall, plate and delay (echo) at 8 delay times at 8 levels. There are 255 combinations, which are all accessable with an editor. The standard MT32 can select 9 room, hall and plate reverbs from the front panel, but the modified machine can select 9 hall, 10 plate, 10 room and 20 delay settings. Exact control over mode, time and level is available via controllers 17, 18 and 19.

WHAT IS A PART ?

There are eight parts in the MT32 (not counting rhythm) and they are data areas which specify how to make sounds. A part is not a piece of hardware. It is an area in the MT32's RAM memory that is ready to specify the creation of sound according to information it contains - if it receives a note on event on its specified channel and there are partials available to make the sound. There are 8 parts so the MT32 could be ready to play 8 different types of sound at any one time. Each part consists of three data areas.

The first area specifies which MIDI channel the part is receiving notes on, the volume and pan of the sounds it will create, and the partial reserve - the number of partials this part will have exclusive rights to over and above the requirements of other parts. The volume can be set from the front panel or by sending control change 7 from MIDI, and the pan can be set by sending control change 10. The special controllers of the modified MT32 enable you to change MIDI receive channels - see page XX.

The second area contains 7 parameters which are usually copied from one of the 128 entries in the patch table. For instance in the acompanying block diagram, if the MT32 received a patch change 128 on channel 4, then the computer program would recognise that only part 3 was receiving on channel 4. The program would look at the 128th entry in the patch table and copy the 7 bytes of data it finds there into the temporary patch area of part 3. The first two bytes specify the 64th timbre in ROM bank A, and so the program copies that timbre data (246 bytes) into the temporary timbre area of part 3. This data includes the name of the timbre (Sitar), and information on how to make the sitar sound - see "What is a timbre ?".

I have not drawn in all the data in the common and partials area of the timbre because it would take a whole page. Now there exists in the part 3 area all the information required to make a sound when a note on event is received on channel 4. Most of the information is in the timbre area, but there are 5 parameters which came from the patch table which affect the sound. The keyshift and fine tune control the coarse and fine tuning with respect to master tune. The bend range specifies how much to alter the pitch when a pitch bend message is received, and the assign mode is to do with different ways of playing multiple notes. Mercifully, portamento has not been implemented. The reverb on/off specifies whether the sound will be fed to the reverb system or not. The special control changes can be used to change the keyshift, fine tune, bend range, assign mode and reverb on/off of each part.

THE PATCH TABLE

This is a table with 128 entries each containing 7 bytes. There is one entry for each possible patch change number, and when a part receives a patch change the 7 bytes from the corresponding entry in the patch table are copied into the temporary patch area of the part.

The first two bytes specify where to find a timbre to copy into the part, and the other five affect the sound production as discussed in the previous section.

Note that the patch table does not contain any names of timbres - although your edit program may display a name for your convenience. Each entry in the patch table says "This is where to find a timbre, and here is some additional information on how to make the sound".

THE DRUM TABLE

This is a table of 64 entries each of 4 bytes. There is one entry for every key on the five octave keyboard from C1 to D#6. Each entry specifies where in the M or R banks to find a timbre, what volume to play it at, what the pan is and whether or not to send the sound to reverb or not.

When a note on event is received on the rhythm receive channel (stored in the setup area), the program looks up that note's entry in the drum table, and plays the timbre the entry points to with the volume, pan and reverb on/off that the entry specifies. The timbre is probably copied to a working area but this is not accessable to us.

If the first byte is 0 then that means "do not make a sound for this note". If it is in the 1 to 64 range then this means "play one of the timbres from bank M". If it is between 65 and 94, then it means "play one of the timbres from bank R". Your edit program may show you timbre names in the drum page, but these are derived from the timbre banks and do not actually exist in the drum table inside the MT32.

THE TIMBRE BANKS

Banks A and B each contain 64 timbres fixed in ROM. These cannot be changed. Most of them are keyboard type timbres which vary the sound's pitch according to the note number. Bank R contains 30 timbres in ROM, but these are timbres which are designed as drum timbres - they mainly use the PCM samples rather than the synth mode of the partials, and they are written so that they play the same pitch no matter where they are played on the keyboard.

A rhythm timbre is really just like any other timbre - you can edit it and store it in the M bank, and play it either as a keyboard sound by making an entry in the patch table point to it, or as a drum timbre by making an entry in the drum table point to it.

The M bank contains timbres that you have editted. In an unmodified MT32 the M bank is loaded with timbres from the ROM banks when the power is turned on.

THE FRONT PANEL

The front panel of a standard MT32 does not allow you to edit the patch table, the drum table, the M bank timbres or any of the eight part areas except for the volume of each part. It does however enable you to load in any of the A or B timbres into any of the parts. This does not involve the patch table but a set of timbre groups and timbres within each group which is stored in the computer program.

USING AN MT32 EDITTING PROGRAM

Each editting program will add its own layer of complexity on top of the MT32, but if you have understood this explanation of the MT32 you will not have too much difficulty understanding the remaining details of the editting program. If you do not have a clear understanding of the data areas as described above you will almost certainly have trouble with an editting program, so please study the above section before firing up a program.

The usual procedure for editting the MT32 involves loading timbre and patch data into one of the parts, editting them and storing the altered data to the patch table and the M bank.

Note that if you create a new timbre, you should give it a distinctive name, store it in one of the 64 M bank locations and change one entry in the patch table so that you can select the new timbre by sending a patch change to the MT32. All editors have a way of saving

the entire "RAM contents" of an MT32 as a disk file, and you should do this regularly. Some editting programs load all data areas from default files on disk when the program is first run - the intention is that you keep your standard MT32 data in these files because the standard MT32 will not remember it. If the program cannot find files with the particular name(s) it is looking for, it will not preload the MT32 with data.

The Roland and Dr T editors do not seem to actually read the MT32's internal data even when connected in bidirecional mode, so any data stored in the MT32 cannot be read into the edit program. These editors presume that the MT32 has just been turned on and therefore contains the default settings in all RAM locations. The program attempts to read default files from disk and send them to the MT32 so that it writes all the MT32's data areas, and from then on it thinks it knows what is going on inside the MT32.

I have been told that the C-LAB MT32 editor does read the data from the MT32's RAM.

I have nearly been driven silly by customers calling me with the question "I have been using an editting program, and have editted some timbres and stored them into bank M, but how do I access them from my sequencer ???" When you look at the level of documentation which accompanies the MT32, and the Roland and DrT editor, it is not surprising that many people get stuck at this point - I certainly did. However my documentation gives you ample explanation of the function of the patch table, and so once you understand that you need to alter an entry in the patch table to point to the new timbre, then you are practically there - you just need to figure out how to do this with your editor.

If you have this problem of being unable to figure out how to select a newly created timbre via a patch change, then you do indeed have a problem - the problem is your MT32 has a patch table and you do not know about it, or do not understand that it is important to you. Your problem has got nothing wahtsoever to do with the modifications, but because your MT32 has been modified by myself or one of my licencees, we are the ones who seem to get the phone calls rather than the people who wrote or sold the editor program.

In an attempt to help you edit your MT32, and avoid problems, here are quick descriptions of how to edit timbres using the Roland editor and the DrT version 2.0 editor.

ROLAND EDITOR

This program has two "Banks" called A and B. These are area in the Atari's memory which store a complete load of data for the MT32. They have nothing whatsoever to do with Timbre Banks A and B inside the MT32.

Firstly FILE LOAD a disk file into one of the banks - A in this example. This reads a disk file containing Setup, Part (I think), Patch, Drum and M bank (64 timbres), and copies this data into the Atari's memory.

Now EDIT LIST TIMBRES. Drag a Timbre name into the workspace. I hink this sends that timbre to part 1 of the MT32.

Now you can EDIT COMMON, EDIT PARTIALS and EDIT ENVELOPES to make a timbre with a different sound and a different name. EDIT PATCH is also available - but don't use it yet.

EDIT LIST TIMBRES. Drag the new name in the workspace to a location in the bank where you want to store it.

EDIT PATCH. Now decide on the Keyshift, Fine Tune, Reverb on/off etc parameters you would like to be in effect.

EDIT LIST PATCHES. Decide which patch change you would like to use to access this Timbre and drag the name in the workspace to the slot for that patch change number.

At this point you may wish to make several patch change entries point to the new Timbre, but with different detunes or whatever. So EDIT PATCH, EDIT LIST PATCHES and drag the name to another patch change slot.

FILE SAVE BANK. This saves your data to disk.

MIDI SEND BANK, This sends all the data in the Atari's memory to the MT32.

Use "load file" to read a set of 64 timbres from a disk file into the Atari's memory. Select one of the 8 parts. Click on the timbre from the big box you wish to edit. It will be copied to the part you have selected.

Now you can use "main edit" and "penv edit" to alter the timbre.

Go back to "timbre bank" and use "store" to copy the new timbre data into one of the locations 1 to 64. Then "send all" - this sends all 64 timbres to the M bank in the MT32.

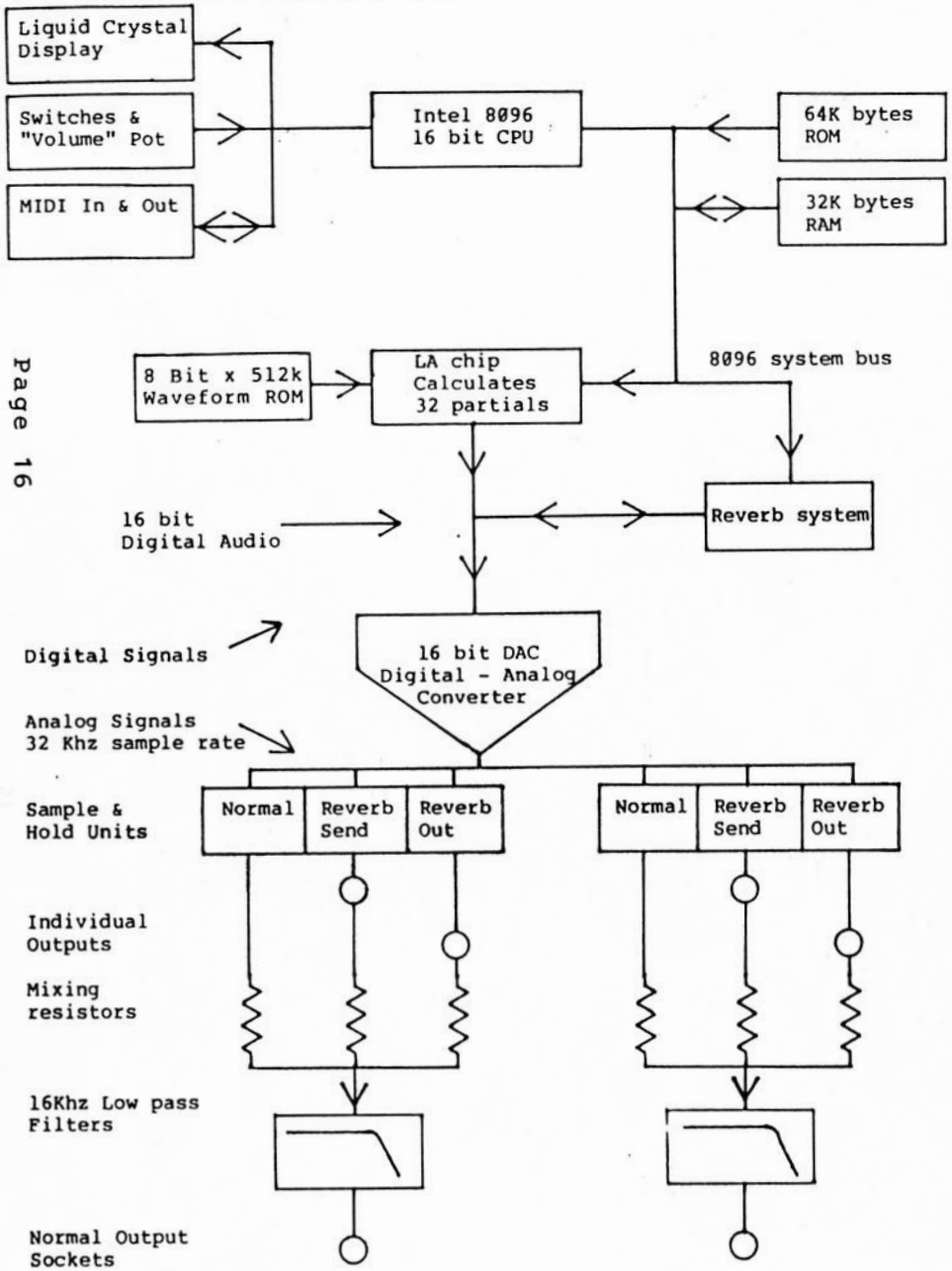
Now go to "patch bnk" and decide which patch entry you wish to use to point to the new timbre. You may wish to load a patch table from disk at this poit. Click on the A, B, M or R and change it to M. Now change the number to the right of M to be the number of the timbre you have just stored. You will see the timbre's name appear next to the number - this is for your edification - the MT32 gets only the M and the number. You can now edit the other patch parameters as you wish.

The DrT editor maintains separate files for the 64 M Timbres, the Patch Table, the Drum Table and the Setup data. You should save these to disk before you finish your session.

BEAVERTON DIGITAL SYSTEMS

In 1989 I licenced my MT32 modifications to John Conelly of Beaverton Digital Systems (in IA), who had Joel Martin (in Oregon) actually carry out the modifications. All was well for a few months but in June it became clear that John's levels of efficiency and honesty were rapidly declining, and so I terminated the licencing arrangement. Unfortunately he has continued to accept MT32s and money from customers, and has continued to advertise the mods. Many customers have been seriously inconvenienced by him, and the whole affair has been extremely expensive and regretable. Unfortunately the cost of legal action means that justice is not a cost effective option in this case, and I am unable to control his activities. If you have had your MT32 modified through John, please contact me because (contrary to our agreement) he has given me no details of who has had their machine modified.

MT32 HARDWARE - BLOCK DIAGRAM



MT32 DATA AREAS - BLOCK DIAGRAM

SETUP DATA

Master Volume	100	Reverb Type	1
Master Tune	0	Reverb Time	5
Rhythm Receive Channel	10	Reverb Level	4
Unit Number	17		

TEMPORARY PATCH AND TIMBRE AREAS OF THE EIGHT PARTS

	PART 1	PART 2	PART 3	PART 4	PART 5	PART 6	PART 7	PART 8
Receive Chan	2	3	4	5	6	7	7	9
Partial Res.	16	4	0	0	0	4	4	0
Volume	95	100	80	100	77	92	92	80
Pan	0	+7	0	0	-4	0	0	0
PATCH DATA								
Timbre Group	M	A	A	B	M	M	M	A
Timbre Number	12	20	64	42	18	2	2	14
Keyshift	0	0	0	0	0	0	0	0
Fine tune	0	0	0	0	0	0	+7	0
Bend range	7	0	0	0	0	0	0	0
Assign mode	1	1	1	1	1	1	1	1
Reverb on/off	ON	OFF	OFF	OFF	OFF	ON	ON	OFF
TIMBRE DATA								
Name	Twang	Sax 2	Sitar	Koto	Zing	Ting	Ting	Pipe2
Common								
Partials 1234								

PATCH TABLE

	1	2	3	4	5	6	. . . . .	128
Timbre Group	M	M	M	B	M	M		A
Timbre Number	12	2	2	42	18	2		64
Keyshift	0	0	0	0	0	0		0
Fine tune	0	0	+7	0	0	0		0
Bend range	7	7	0	0	0	0		0
Assign mode	1	1	1	1	1	1		1
Reverb on/off	ON	ON	OFF	OFF	OFF	OFF		OFF

DRUM TABLE

	C0	C#0	D0	. . .	C3	C#3	. . . . .	D5	D#5
= Note number	24	25	26		60	61		86	87
Timbre Number	65	71	71		20	21		75	78
Volume	80	80	80		97	80		100	80
Pan	0	-7	+7		+7	+7		-7	0
Reverb on/off	OFF	ON	OFF		ON	ON		OFF	OFF

TIMBRE BANKS

A	B	R	M
64 Timbres fixed in ROM	64 Timbres fixed in ROM	30 Timbres fixed in ROM	64 Timbres read/write in RAM

MT-32

Sound List

Roland

Prog-No. [HP-Prog] Use Partial
Timbre name

PRESET TIMBRE MAP

PIANO							
001 [A11] 4 Acou Piano 1	002 [A12] 2 Acou Piano 2	003 [A13] 1 Acou Piano 3	004 [A14] 3 Elec Piano 1	005 [A15] 2 Elec Piano 2	006 [A16] 2 Elec Piano 3	007 [A17] 1 Elec Piano 4	008 [A18] 3 Honkytonk
ORGAN							
009 [A21] 3 Elec Org 1	010 [A22] 3 Elec Org 2	011 [A23] 2 Elec Org 3	012 [A24] 2 Elec Org 4	013 [A25] 3 Pipe Org 1	014 [A26] 3 Pipe Org 2	015 [A27] 2 Pipe Org 3	016 [A28] 2 Accordion
KEYBRD							
017 [A31] 4 Harpsi 1	018 [A32] 2 Harpsi 2	019 [A33] 1 Harpsi 3	020 [A34] 3 Clavi 1	021 [A35] 2 Clavi 2	022 [A36] 1 Clavi 3	023 [A37] 4 Celesta 1	024 [A38] 2 Celesta 2
S-BRASS				**SYNBASS**			
025 [A41] 2 Syn Brass 1	026 [A42] 3 Syn Brass 2	027 [A43] 2 Syn Brass 3	028 [A44] 2 Syn Brass 4	029 [A45] 2 Syn Bass 1	030 [A46] 2 Syn Bass 2	031 [A47] 2 Syn Bass 3	032 [A48] 1 Syn Bass 4
SYNTH 1							
033 [A51] 3 Fantasy	034 [A52] 3 Harmo Pan	035 [A53] 3 Chorale	036 [A54] 2 Glasses	037 [A55] 4 Soundtrack	038 [A56] 4 Atmosphere	039 [A57] 4 Warm Bell	040 [A58] 1 Funny Vox
SYNTH 2							
041 [A61] 3 Echo Bell	042 [A62] 3 Ice Rain	043 [A63] 2 Oboe 2001	044 [A64] 2 Echo Pan	045 [A65] 2 Doctor Solo	046 [A66] 2 Schooldaze	047 [A67] 2 Bellsinger	048 [A68] 2 Square Wave
STRINGS							
049 [A71] 4 Str Sect 1	050 [A72] 3 Str Sect 2	051 [A73] 2 Str Sect 3	052 [A74] 3 Pizzicato	053 [A75] 3 Violin 1	054 [A76] 2 Violin 2	055 [A77] 3 Cello 1	056 [A78] 2 Cello 2
			GUITAR				
057 [A81] 2 Contrabass	058 [A82] 3 Harp 1	059 [A83] 2 Harp 2	060 [A84] 2 Guitar 1	061 [A85] 2 Guitar 2	062 [A86] 4 Elec Gtr 1	063 [A87] 3 Elec Gtr 2	064 [A88] 4 Sitar

MT-32

Sound List

Roland

Prog-No. [HP-Prog] Use Partial
Timbre name

PRESET TIMBRE MAP

BASS							
065 [B11] 2 Acou Bass 1	066 [B12] 1 Acou Bass 2	067 [B13] 2 Elec Bass 1	068 [B14] 1 Elec Bass 2	069 [B15] 3 Slap Bass 1	070 [B16] 2 Slap Bass 2	071 [B17] 4 Fretless 1	072 [B18] 2 Fretless 2
WIND 1						**WIND 2**	
073 [B21] 4 Flute 1	074 [B22] 2 Flute 2	075 [B23] 3 Piccolo 1	076 [B24] 2 Piccolo 2	077 [B25] 2 Recorder	078 [B26] 3 Pan Pipes	079 [B27] 4 Sax 1	080 [B28] 3 Sax 2
081 [B31] 2 Sax 3	082 [B32] 1 Sax 4	083 [B33] 3 Clarinet 1	084 [B34] 2 Clarinet 2	085 [B35] 2 Oboe	086 [B36] 2 Engl Horn	087 [B37] 2 Bassoon	088 [B38] 2 Harmonica
BRASS							
089 [B41] 3 Trumpet 1	090 [B42] 2 Trumpet 2	091 [B43] 3 Trombone 1	092 [B44] 2 Trombone 2	093 [B45] 3 Fr Horn 1	094 [B46] 2 Fr Horn 2	095 [B47] 2 Tuba	096 [B48] 4 Brs Sect 1
	MALLET						
097 [B51] 3 Brs Sect 2	098 [B52] 3 Vibe 1	099 [B53] 2 Vibe 2	100 [B54] 1 Syn Mallet	101 [B55] 3 Windbell	102 [B56] 2 Glock	103 [B57] 4 Tube Bell	104 [B58] 1 Xylophone
	SPECIAL						
105 [B61] 3 Marimba	106 [B62] 2 Koto	107 [B63] 4 Sho	108 [B64] 4 Shakuhachi	109 [B65] 2 Whistle 1	110 [B66] 1 Whistle 2	111 [B67] 4 Bottleblow	112 [B68] 3 Breathpipe
PERCUSN							
113 [B71] 2 Timpani	114 [B72] 1 Melodic Tom	115 [B73] 2 Deep Snare	116 [B74] 2 Elec Perc 1	117 [B75] 2 Elec Perc 2	118 [B76] 3 Taiko	119 [B77] 1 Taiko Rim	120 [B78] 2 Cymbal
		EFFECTS					
121 [B81] 2 Castanets	122 [B82] 2 Triangle	123 [B83] 4 Orche Hit	124 [B84] 1 Telephone	125 [B85] 1 Bird Tweet	126 [B86] 4 One Note Jam	127 [B87] 3 Water Bells	128 [B88] 4 Jungle Tune