



The twelfth in a series of tutorials for the beginner to intermediate machine language programmer

# Machine Language Made BASIC

## Part XII: And the Music Played On

By William P. Nee

This month we'll use many of the machine language routines discussed in previous articles to create a music program that plays six voices (notes) simultaneously, and lets you change the timbre of the notes to create different sounds. First, let's decide what to put in the program and how to do it. Trying to make this as much like the PLAY command as possible, I suggest using the following values:

Note (C - B) with a sharp (#) or flat (-)

Octave (1 - 5)

Tempo (1 - 5)

Length: 1 = whole note (#\$80)

2 = half note (#\$40)

3 = quarter note triplet (#\$15)

4 = quarter note (#\$20)

5 = thirty-second note (#\$4)

6 = sixteenth note (#\$8)

7 = eighth note triplet (#\$A)

8 = eighth note (#\$10)

\*9 = sixty-fourth note (#\$2)

Rest

\*Use for separating like notes or playing grace notes.

Since there are no graphics for this program, start it very low in memory to give plenty of room for each chord. Set Location \$FF/100 to #\$E00 and ORG at \$2000. Reserve one memory byte for a note counter (NOTECT RMB 1) and load it with #6, since there are six notes in each chord. Reserve one memory byte each for Tempo, Length, Octave and temporary Octave 1. Chord information is put in as FCC lines. Once you set the Octave, Tempo and Length,

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you do not need to re-enter them unless they change.

Label the start of the notes as NTABLE, remembering that using FCC lines enters the character's ASCII number (A = #\$41, I = #\$31, etc.). (EDTASM+ only allows 250 characters per FCC line.) You can also number the NTABLE(s) for easy reference or corrections at each stanza, movement, page, etc.

The vocabulary check pauses or "reads" each chord. First, load Register X with the

location of the NTABLE (LDX #NTABLE). Register X will now always contain the current chord location in the NTABLE. Load Stack U with the location \$4100, where the numerical value of each note is stored and saved. Load Register A with the contents of Register X (get the first character in the note chord) and increase Register X by one (LDA ,X+).

Is the first character an R? If not, go to the next check. If it is a Rest, load Register

### The Listing: 6VOICES

```

                $FF/100=#$E00
                ORG      $2000
2000 CE 4100    00100 *   START LDU  #$4100  START OF FIRST CHORD
2003 8E 2111    00110 *   LDX  #NTABLE
2006 C6 06     00130 *   CHORD LDB  #6      SIX NOTES TO THE CHORD
2008 F7 2461    00140 *   STB  NOTECT
200B A6 80     00150 *   VOC  LDA  ,X+   GET THE FIRST CHARACTER
200D 1027 0FEF  00160 *   LBEQ PLAYER IF IT'S ZERO THATS ALL
2011 81 3B     00170 *   CMPA #' ;
2013 27 F6     00180 *   BEQ  VOC    PASS OVER A " ; "
2015 81 52     00190 *   REST CMPA #' R   IS IT A REST
2017 26 16     00200 *   BNE  TEMP
2019 FC 2462    00210 *   LDD  TEMPO GET THE TEMPO AND LENGTH
201C ED C1     00220 *   STD  ,U++  THEY START EACH CHORD
201E CC 0000    00230 *   LDD  #0    FILL IN SIX ZERO NOTES
2021 ED C1     00240 *   STD  ,U++
2023 ED C1     00250 *   STD  ,U++
2025 ED C1     00260 *   STD  ,U++
2027 ED C1     00270 *   STD  ,U++
2029 ED C1     00280 *   STD  ,U++
202B ED C1     00290 *   STD  ,U++
202D 20 D7     00300 *   BRA  CHORD
202F 81 54     00310 *   TEMP CMPA #' T   IS IT TEMPO
2031 26 0C     00320 *   BNE  LEN
2033 A6 80     00330 *   LDA  ,X+
2035 80 30     00340 *   SUBA #$30  GET THE TEMPO NUMBER
2037 C6 14     00350 *   LDB  #20   FOR DIFFERENT TEMPOS
2039 3D        00360 *   MUL
203A F7 2462    00370 *   STB  TEMPO
203D 20 CC     00380 *   BRA  VOC
203F 81 4C     00390 *   LEN  CMPA #' L   IS IT LENGTH
2041 26 0F     00400 *   BNE  OCT
2043 A6 80     00410 *   LDA  ,X+
2045 80 30     00420 *   SUBA #$30  GET THE LENGTH NUMBER
2047 108E 2436  00430 *   LDY  #LTABLE
    
```

D with the current tempo, store it at Location U, and increase U by two. Then clear Register D, store it at Location U, and increase U by two. Do this five more times to get the six notes, and return to the vocabulary check. If the character is not T, go to the next vocabulary check; if it is, read the next character, which must be a number. Since it is in ASCII, subtract #30 to get the actual number value; multiply this by 20 (just to get tempo changes) and store the result in TEMPO. Go back to the vocabulary check; if the character is not L, go to the next check; if it is, read the next character, which must be a number. Again, subtract #30 to get the number value.

The actual note lengths are stored in LTABLE, so if you load Register Y with the LTABLE location and Register B with the A value in the table (LDB A, Y), Register B will then contain the actual note length. Go back to the vocabulary check; if the next character is not an O, go to the next check. If it is, read the next character, which must be a number. Subtract #30 to get the number value (1 to 5) and store it in OCTAVE. Go back to the vocabulary check.

If the character isn't any of the above, it must be a note (C, D, E, F, G, A, B). First, increase the note location by two. Notes are always bytes 3 to 14, in our chord; the first two bytes are the tempo and length. Because there are 12 steps in an octave, convert a C to Note 1, D to Note 3, etc. The notes are in ASCII format so subtract #341 to get a number value (A will = 0, B will = 1, etc.).

CTABLE gives the note number assigned to each letter (A is the 10th note, B is the 11th note, G is the 8th note, etc.). Load Register Y with the CTABLE location and load Register B with the A value (LDB A, Y) to get the actual note value (C=1, D=3, E=5, F=6, G=8, A=10 and B=12). Now, check the next character to see if it is a sharp (#) or flat (-); if it's a sharp, increase the note value by one (C#=2, F#=7, etc.); if it's a flat, decrease the note value by one (E=-4, B=-11, etc.). Don't use C- or B# as they will blow the program.

If the next character after the note is not a sharp or a flat, decrease the vocabulary location by one, back to it's previous location. Now convert the note to a value the computer can use to play it. First, decrease the note numbers one to 12 by one, to get numbers from zero to 11, then load the current OCTAVE into a temporary OCT1. Multiply the note number (zero to 11) by two.

The location SCALE contains the frequency for each note (zero to 11). Each frequency is two bytes - that's why we multiplied the note number by two. If we load Register Y with the scale location and

204B	E6	A6	00440	LDB	A, Y	GET THE LENGTH VALUE
204D	F7	2463	00450	STB	LENGTH	
2050	20	B9	00460	BRA	VOC	
2052	81	4F	00470	OCT	CMPA	#'0 IS IT OCTAVE
2054	26	09	00480	BNE	NOTE	
2056	A6	80	00490	LDA	,X+	
2058	80	30	00500	SUBA	#30	GET THE OCTAVE NUMBER
205A	B7	245F	00510	STA	OCTAVE	
205D	20	AC	00520	BRA	VOC	
205F	33	42	00530	NOTE	LEAU	2, U INCREASE CHORD LOCATION BY TWO
2061	80	41	00540	SUBA	#341	GET THE LETTER COUNT
2063	108E	2440	00550	LDY	#CTABLE	
2067	E6	A6	00560	LDB	A, Y	GET THE LETTER VALUE
2069	A6	80	00570	LDA	,X+	CHECK FOR SHARP OR FLAT
206B	81	23	00580	CSHARP	CMPA	#'# IS IT A SHARP
206D	26	03	00590	BNE	CFLAT	
206F	5C		00600	INCB		INCREASE THE NOTE VALUE BY ONE
2070	20	09	00610	BRA	STORE	
2072	81	2D	00620	CFLAT	CMPA	#'- IS IT A FLAT
2074	26	03	00630	BNE	CDEC	
2076	5A		00640	DECB		DECREASE THE NOTE VALUE BY ONE
2077	20	02	00650	BRA	STORE	
2079	30	1F	00660	CDEC	LEAX	-1, X IT WASN'T EITHER; DECREASE THE
LOCATION						
207B	5A		00670	STORE	DECB	GET NOTE VALUE 0 - 11
207C	B6	245F	00680	LDA	OCTAVE	
207F	B7	2460	00690	STA	OCT1	TEMPORARY OCTAVE
2082	86	02	00700	LDA	#2	
2084	3D		00710	MUL		
2085	108E	2447	00720	LDY	#SCALE	
2089	EC	A5	00730	LDD	B, Y	NOTE FREQUENCY FOR OCTAVE 0
208B	7A	2460	00740	ROTATE	DEC	OCT1
208E	27	04	00750	BEQ	SAVE	OK IF IT'S OCTAVE 0
2090	58		00760	ASLB		IF NOT, DOUBLE THE FREQUENCY
2091	49		00770	ROLA		
2092	20	F7	00780	BRA	ROTATE	NOW IS OCTAVE 0
2094	ED	C4	00790	SAVE	STD	, U STORE THE 2-BYTE FREQUENCY
2096	7A	2461	00800	DEC	NOTECT	ONE LESS NOTE TO GET
2099	27	18	00810	BEQ	LOOP	CHORD'S GOT ALL SIX NOTES
209B	A6	80	00820	LDA	,X+	
209D	81	3B	00830	CMPA	#';	
209F	27	06	00840	BEQ	FINISH	NO MORE NOTES IN THIS CHORD
20A1	81	4F	00850	CMPA	#'0	OCTAVE CHANGE?
20A3	27	AD	00860	BEQ	OCT	
20A5	20	B8	00870	BRA	NOTE	MUST BE ANOTHER NOTE
20A7	CC	0000	00880	FINISH	LDD	#0
20AA	33	42	00890	CFIN	LEAU	2, U FILL IN THE CHORD WITH ZEROS
20AC	ED	C4	00900	STD	, U	
20AE	7A	2461	00910	DEC	NOTECT	
20B1	26	F7	00920	BNE	CFIN	ALL DONE?
20B3	FC	2462	00930	LOOP	LDD	TEMPO
20B6	ED	54	00940	STD	-12, U	PUT THEM AT START OF CHORD
20B8	33	42	00950	LEAU	2, U	START OF NEXT CHORD
20BA	16	FF49	00960	LBRA	CHORD	
20BD	20		00970	TITLE	FCC	/ * CHINESE SERENADE *
BY HERMAN FLIEGE/						
210F	0D00	00980	FDB	\$000		
2111	54	00990	NTABLE	FCC	/T5L804DC03A02F#F#F#; 04DC03ADCO2A; 04DC0	
3A02DDD; 04DC03ADCO2A/						
214B	4F	01000	FCC	/04D03B-G02GGG; 04G03D02B-; 04D03B-G02DDD		
; 04D03B-GD02B-; /						
2180	4F	01010	FCC	/04DC03AF#F#F#; 04A03DC02A; 04DC03A02D; 04		
DC03ADCO2A; /						
21B1	4F	01020	FCC	/04D03B-G02G; 04B-03D02B-; 04D03B-G02D; 04		
D03B-GD02B-; /						
21E3	4F	01030	FCC	/04DC03A02F#F#F#; 04DC03ADCO2A; 04DC03A02		
DDD; 04DC03ADCO2A/						
2219	4F	01040	FCC	/04D03B-G02GGG; 04G03D02B-; 04D03B-G02DDD		
; 04D03B-GD02B-; /						
224E	4F	01050	FCC	/04DC03A02F#F#F#; 05D04D03DC02A; 05D04D02		
D; 04F#DC03DC02A; /						
2284	4F	01060	FCC	/04GD03B-D02B-G; R; L405G04G02G01G; /		
22A4	4C	01070	FCC	/L804DC03A02F#F#F#; 04DC03ADCO2A; 04DC03A		
02DDD; 04DC03ADCO2A/						
22DC	4F	01080	FCC	/04D03B-G02GGG; 04G03D02B-; 04D03B-G02DDD		
; 04D03B-GD02B-; /						
2311	4F	01090	FCC	/04DC03AF#F#F#; 04A03DC02A; 04DC03A02D; 04		
DC03ADCO2A; /						
2342	4F	01100	FCC	/04D03B-G02G; 04B-03D02B-; 04D03B-G02D; 04		
D03B-GD02B-; /						
2374	4F	01110	FCC	/04DC03A02F#F#F#; 04DC03ADCO2A; 04DC03A02		
DDD; 04DC03ADCO2A/						
23AA	4F	01120	FCC	/04D03B-G02GGG; 04G03D02B-; 04D03B-G02DDD		
; 04D03B-GD02B-; /						

```

23DF 4F 01130 FCC /O4DC03A02F#F#F#;O5D04D03DC02A;O5D04D02
D;O4F#DC03DC02A;/
2415 4F 01140 FCC /O4GD03B-D02B-G;R;L405G04G02G01G;/
2435 00 01150 FCB 0 END OF THE MUSIC
2436 0080 01160 LTABLE FDB $0080 NOTE LENGTHS
2438 4015 01170 FDB $4015
243A 2004 01180 FDB $2004
243C 008A 01190 FDB $008A
243E 1002 01200 FDB $1002
2440 0A0C 01210 CTABLE FDB $0A0C NUMBER VALUES FOR NOTE LETTERS
2442 0103 01220 FDB $0103
2444 0506 01230 FDB $0506
2446 08 01240 FCB $08
2447 02B6 01250 SCALE FDB $02B6 NOTE FREQUENCIES
2449 02DF 01260 FDB $02DF
244B 030B 01270 FDB $030B
244D 0339 01280 FDB $0339
244F 036A 01290 FDB $036A
2451 039E 01300 FDB $039E
2453 03D6 01310 FDB $03D6
2455 0410 01320 FDB $0410
2457 044E 01330 FDB $044E
2459 048F 01340 FDB $048F
245B 04D5 01350 FDB $04D5
245D 051E 01360 FDB $051E
245F 01370 OCTAVE RMB 1
2460 01380 OCT1 RMB 1
2461 01390 NOTECT RMB 1
2462 01400 TEMPO RMB 1
2463 01410 LENGTH RMB 1
3000 01420 ORG $3000
3000 6F C4 01430 PLAYER CLR ,U END THE MUSIC WITH ZEROS
3002 BD A928 01440 JSR $A928 CLS
3005 8E 20BD 01450 LDX #TITLE
3008 CC 04E5 01460 LDD #$4E5 PRINT @ LOCATION
300B DD 88 01470 STD $88 INTO CURSOR LOCATION
300D BD B99C 01480 JSR $B99C PRINT THE TITLE
3010 8E 30CB 01490 FILL LDX #TCURVE START OF TIMBRE CURVE
3013 CE 4000 01500 LDU #$4000 WHERE TO STORE IT
3016 EC 81 01510 LOOP3 LDD ,X++
3018 ED C1 01520 STD ,U++
301A 1183 4100 01530 CMPU #$4100
301E 25 F6 01540 BLO LOOP3
3020 34 01 01550 PSHS CG
3022 1A 50 01560 ORCC #$50 NO INTERRUPTS
3024 5F 01570 CLR CLRB
3025 BD A9A2 01580 JSR $A9A2 SET SOUND ON
3028 BD A976 01590 JSR $A976
302B 86 3F 01600 LDA #$3F LOTS OF LOCATIONS AT $3F00 - $3
FFF
302D 1F 8B 01610 TFR A,DP SET THE DP REGISTER TO #$FF
302F 86 40 01620 LDA #$40 START OF TCURVE LOCATION
3031 97 C0 01630 STA $C0
3033 0F C1 01640 CLR $C1
3035 0F C2 01650 CLR $C2
3037 97 C3 01660 STA $C3
3039 0F C4 01670 CLR $C4
303B 0F C5 01680 CLR $C5
303D 97 C6 01690 STA $C6
303F 0F C7 01700 CLR $C7
3041 0F C8 01710 CLR $C8
3043 97 C9 01720 STA $C9
3045 0F CA 01730 CLR $CA
3047 0F CB 01740 CLR $CB
3049 97 CC 01750 STA $CC
304B 0F CD 01760 CLR $CD
304D 0F CE 01770 CLR $CE
304F 97 CF 01780 STA $CF
3051 0F D0 01790 CLR $D0
3053 0F D1 01800 CLR $D1
3055 108E 4100 01810 PLAY LDY #$4100 START OF CHORDS LOCATION
3059 6D A4 01820 LOOP1 TST ,Y IS FIRST VALUE A ZERO
305B 27 65 01830 BEQ OVER
305D EC A1 01840 LDD ,Y++ GET THE TEMPO AND LENGTH
305F 97 D3 01850 STA $D3 TEMPO
3061 97 D4 01860 STA $D4 TEMPORARY TEMPO
3063 D7 D2 01870 STB $D2 LENGTH
3065 A6 9F 3FC0 01880 LOOP2 LDA [$3FC0] GET ALL THE TCURVE VALUES
3069 AB 9F 3FC3 01890 ADDA [$3FC3]
306D A9 9F 3FC6 01900 ADCA [$3FC6]
3071 A9 9F 3FC9 01910 ADCA [$3FC9]
3075 A9 9F 3FCC 01920 ADCA [$3FCC]
3079 A9 9F 3FCF 01930 ADCA [$3FCF]
307D B7 FF20 01940 STA $FF20 PUT THEM IN PIA
3080 DC C1 01950 LDD $C1

```

Register D with the B value in the scale, we get that note's frequency. However, that frequency is only for the lowest octave. As in actual music, each octave increase will double the note's frequency, so it is necessary to first decrease the temporary OCT1 (1 to 5) by one to get 0 to 4. If it is a zero, it is in the lowest octave and doesn't need to have the note frequency changed. If it is greater than zero, shift Register D (the note frequency) to the left (double it) with:

```
ASLB
ROLA
```

Then decrease the temporary Octave 1 count by one. If the temporary OCT is still not zero, keep decreasing it and doubling Register D. When OCT1 is finally zero, save the note frequency by storing it at Location U.

Since we now have a note, decrease NOTECT by one. If NOTECT has reached zero, that is the end of the chord. If the NOTECT is not zero, check the next character in the chord. If it is a ",", that's the end of the chord (fill up the remainder of the chord with zeros). If it is an O branch to OCT, or else branch always back to note.

When a chord is complete, the tempo and length are stored at the beginning of the chord location and the whole process starts back at CHORD. If the first character of a chord is zero, it means the music is over. Be sure that the last entry in the NTABLE is FCB 0.

Each chord is now 14 bytes long — one byte each for the tempo and length and two bytes each for the six notes. You can give your program a title. The program will accept a ";" between chords to make it easier to read them. It is not necessary to make each chord a separate FCC line.

First, a word about a new register, the DP register. When using a command like LDA \$C0, EDTASM+ first looks to the DP register to get a one-byte number to go before the \$C0. Since the DP register is initially set to zero, the command is really LDA \$00C0. However, you can change the DP register. If using a lot of commands involving locations from \$3F00 to \$3FFF, let the DP register assign the \$3F, and you assign the other half. This saves both time and memory.

We can't directly set the DP register, however. Since it is such an important register, the computer doublechecks whether you actually want to change it. So, use this to change it:

```
LDA #$3F
TFR A,DP
```

Now, using LDA \$C0, the computer actu-

3082	E3	A4	01960	ADDD	,Y	NOTE 1
3084	DD	C1	01970	STD	\$C1	
3086	DC	C4	01980	LDD	\$C4	
3088	E3	22	01990	ADDD	2,Y	NOTE 2
308A	DD	C4	02000	STD	\$C4	
308C	DC	C7	02010	LDD	\$C7	
308E	E3	24	02020	ADDD	4,Y	NOTE 3
3090	DD	C7	02030	STD	\$C7	
3092	DC	CA	02040	LDD	\$CA	
3094	E3	26	02050	ADDD	6,Y	NOTE 4
3096	DD	CA	02060	STD	\$CA	
3098	DC	CD	02070	LDD	\$CD	
309A	E3	28	02080	ADDD	8,Y	NOTE 5
309C	DD	CD	02090	STD	\$CD	
309E	DC	D0	02100	LDD	\$D0	
30A0	E3	2A	02110	ADDD	10,Y	NOTE 6
30A2	DD	D0	02120	STD	\$D0	
30A4	0A	D4	02130	DEC	\$D4	DECREASE TEMPORARY TEMPO
30A6	26	0E	02140	BNE	DELAY	
30A8	0A	D2	02150	DEC	\$D2	DECREASE LENGTH
30AA	26	04	02160	BNE	CONT1	
30AC	31	2C	02170	LEAY	12,Y	NEXT CHORD LOCATION
30AE	20	A9	02180	BRA	LOOP1	
30B0	D6	D3	02190	LDB	\$D3	TEMPO
30B2	D7	D4	02200	STB	\$D4	TEMPORARY TEMPO
30B4	20	AF	02210	BRA	LOOP2	
30B6	30	84	02220	DELAY	LEAX	JUST MAKES A QUICK PAUSE
30B8	30	84	02230	LEAX	,X	
30BA	86	00	02240	LDA	#0	
30BC	86	00	02250	LDA	#0	
30BE	86	00	02260	LDA	#0	
30C0	20	A3	02270	BRA	LOOP2	
30C2	4F		02280	OVER	CLRA	
30C3	1F	8B	02290	TFR	A,DP	SET THE DP REGISTER BACK TO ZERO
30C5	35	01	02300	PULS	CC	
30C7	BD	A974	02310	JSR	\$A974	SOUND OFF
30CA	3F		02320	SWI		RTS IF IN BASIC
30CB	1415		02330	TFCURVE	FDB	\$1415
30CD	1516		02340	FDB		\$1516
30CF	1718		02350	FDB		\$1718
30D1	1819		02360	FDB		\$1819
30D3	1A1A		02370	FDB		\$1A1A
30D5	1B1C		02380	FDB		\$1B1C
30D7	1C1D		02390	FDB		\$1C1D
30D9	1E1E		02400	FDB		\$1E1E
30DB	1E1F		02410	FDB		\$1E1F
30DD	2020		02420	FDB		\$2020
30DF	2121		02430	FDB		\$2121
30E1	2222		02440	FDB		\$2222
30E3	2223		02450	FDB		\$2223
30E5	2324		02460	FDB		\$2324
30E7	2424		02470	FDB		\$2424
30E9	2424		02480	FDB		\$2424
30EB	2425		02490	FDB		\$2425
30ED	2525		02500	FDB		\$2525
30EF	2525		02510	FDB		\$2525
30F1	2525		02520	FDB		\$2525
30F3	2525		02530	FDB		\$2525
30F5	2525		02540	FDB		\$2525
30F7	2524		02550	FDB		\$2524
30F9	2424		02560	FDB		\$2424
30FB	2424		02570	FDB		\$2424
30FD	2423		02580	FDB		\$2423
30FF	2323		02590	FDB		\$2323
3101	2322		02600	FDB		\$2322
3103	2222		02610	FDB		\$2222
3105	2121		02620	FDB		\$2121
3107	2121		02630	FDB		\$2121
3109	2120		02640	FDB		\$2120
310B	2020		02650	FDB		\$2020
310D	1F1F		02660	FDB		\$1F1F
310F	1F1E		02670	FDB		\$1F1E
3111	1E1E		02680	FDB		\$1E1E
3113	1E1D		02690	FDB		\$1E1D
3115	1D1D		02700	FDB		\$1D1D
3117	1D1C		02710	FDB		\$1D1C
3119	1C1C		02720	FDB		\$1C1C
311B	1C1B		02730	FDB		\$1C1B
311D	1B1B		02740	FDB		\$1B1B
311F	1B1A		02750	FDB		\$1B1A
3121	1A1A		02760	FDB		\$1A1A
3123	1A1A		02770	FDB		\$1A1A
3125	1A19		02780	FDB		\$1A19
3127	1919		02790	FDB		\$1919

ally executes LDA \$3FC0. Since speed is critical in a music program, use the DP register frequently, remembering to set it back to zero when finished.

Next, is how to create a timbre curve (TCURVE), which is a numerical plot of the frequency each voice traces on a graph — all the highs and lows. It is this curve that gives each musical instrument its distinctive sound.

You can make a different curve for each voice, but this program uses the same curve for all six. Be sure that no single curve byte times the number of voices is greater than 255. In this curve, the highest byte can be  $255/6 = 42$  or #2A.

The curve is stored from \$3000 to \$30FF (256 bytes). The two ROM subroutines set the computer to play notes. Next, set the DP register to #3F. The location of our TCURVE(s) is stored at \$(3F)C0, \$(3F)C3, \$(3F)C6, \$(3F)C9, \$(3F)CC, and \$(3F)CF. Now, load Register Y with the chord start location; the first thing the program will check is if the chord starts with zero. If so, this is the end of the music and the program turns off the sound and ends; if not a zero, the program loads the current tempo into \$(3F)D3, a temporary tempo into \$(3F)D4, and the length into \$(3F)D2.

The TCURVE value for each voice is added together and stored in \$FF20. Note 1 is stored at \$(3F)C1, Note 2 at \$(3F)C4, Note 3 at \$(3F)C7, Note 4 at \$(3F)CA, Note 5 at \$(3F)CD, and Note 6 at \$(3F)D0. Remember, each note is two bytes long. The temporary tempo in \$(3F)D4 is decreased by one. If it is not zero, a short delay (pause) is executed just for timing, then the program adds together the second byte of each timbre curve.

This continues until Tempo 1 has reached zero. When it has, the length is decreased and the whole cycle repeats until both the length and the tempo have reached zero. Register Y is loaded with the start of the next chord location, and everything repeats until all of the chords have been played and the program ends.

You may find it easier to enter the music one FCC line at a time, and then play it. Be sure to keep a FCB 0 at the end of the music. You can also watch your text program more closely, this way, to be sure it is not running into the TCURVE. If there are a lot of notes, you can relocate the TCURVE and chord start locations. If there are six different TCURVES, you will have to change locations. Just be sure that the start of each TCURVE is stored at \$(DP)C0, \$(DP)C3, \$(DP)C6, \$(DP)C9, \$(DP)CC and \$(DP)CF.

*(Questions or comments about this tutorial may be directed to the author at Route 2, Box 216C, Mason, WI 54856-9302. Please enclose an SASE when requesting a reply.)*

3129	1919	Ø28ØØ	FDB	\$1919
312B	1818	Ø281Ø	FDB	\$1818
312D	1818	Ø282Ø	FDB	\$1818
312F	1818	Ø283Ø	FDB	\$1818
3131	1818	Ø284Ø	FDB	\$1818
3133	1717	Ø285Ø	FDB	\$1717
3135	1717	Ø286Ø	FDB	\$1717
3137	1717	Ø287Ø	FDB	\$1717
3139	1616	Ø288Ø	FDB	\$1616
313B	1616	Ø289Ø	FDB	\$1616
313D	1616	Ø29ØØ	FDB	\$1616
313F	1515	Ø291Ø	FDB	\$1515
3141	1515	Ø292Ø	FDB	\$1515
3143	1515	Ø293Ø	FDB	\$1515
3145	1515	Ø294Ø	FDB	\$1515
3147	1514	Ø295Ø	FDB	\$1514
3149	1414	Ø296Ø	FDB	\$1414
314B	1414	Ø297Ø	FDB	\$1414
314D	1313	Ø298Ø	FDB	\$1313
314F	1313	Ø299Ø	FDB	\$1313
3151	1313	Ø3ØØØ	FDB	\$1313
3153	1313	Ø3Ø1Ø	FDB	\$1313
3155	1312	Ø3Ø2Ø	FDB	\$1312
3157	1212	Ø3Ø3Ø	FDB	\$1212
3159	1212	Ø3Ø4Ø	FDB	\$1212
315B	1111	Ø3Ø5Ø	FDB	\$1111
315D	1111	Ø3Ø6Ø	FDB	\$1111
315F	1111	Ø3Ø7Ø	FDB	\$1111
3161	111Ø	Ø3Ø8Ø	FDB	\$111Ø
3163	1Ø1Ø	Ø3Ø9Ø	FDB	\$1Ø1Ø
3165	1Ø1Ø	Ø31ØØ	FDB	\$1Ø1Ø
3167	1Ø1Ø	Ø311Ø	FDB	\$1Ø1Ø
3169	1Ø1Ø	Ø312Ø	FDB	\$1Ø1Ø
316B	ØFØF	Ø313Ø	FDB	\$ØFØF
316D	ØFØF	Ø314Ø	FDB	\$ØFØF
316F	ØFØE	Ø315Ø	FDB	\$ØFØE
3171	ØEØE	Ø316Ø	FDB	\$ØEØE
3173	ØEØE	Ø317Ø	FDB	\$ØEØE
3175	ØEØD	Ø318Ø	FDB	\$ØEØD
3177	ØDØD	Ø319Ø	FDB	\$ØDØD
3179	ØDØC	Ø32ØØ	FDB	\$ØDØC

317B	ØCØC	Ø321Ø	FDB	\$ØCØC
317D	ØCØC	Ø322Ø	FDB	\$ØCØC
317F	ØBØB	Ø323Ø	FDB	\$ØBØB
3181	ØBØB	Ø324Ø	FDB	\$ØBØB
3183	ØAØA	Ø325Ø	FDB	\$ØAØA
3185	ØAØ9	Ø326Ø	FDB	\$ØAØ9
3187	Ø9Ø9	Ø327Ø	FDB	\$Ø9Ø9
3189	Ø9Ø8	Ø328Ø	FDB	\$Ø9Ø8
318B	Ø8Ø8	Ø329Ø	FDB	\$Ø8Ø8
318D	Ø7Ø7	Ø33ØØ	FDB	\$Ø7Ø7
318F	Ø7Ø7	Ø331Ø	FDB	\$Ø7Ø7
3191	Ø6Ø6	Ø332Ø	FDB	\$Ø6Ø6
3193	Ø6Ø5	Ø333Ø	FDB	\$Ø6Ø5
3195	Ø5Ø5	Ø334Ø	FDB	\$Ø5Ø5
3197	Ø5Ø5	Ø335Ø	FDB	\$Ø5Ø5
3199	Ø4Ø4	Ø336Ø	FDB	\$Ø4Ø4
319B	Ø4Ø4	Ø337Ø	FDB	\$Ø4Ø4
319D	Ø4Ø3	Ø338Ø	FDB	\$Ø4Ø3
319F	Ø3Ø3	Ø339Ø	FDB	\$Ø3Ø3
31A1	Ø3Ø3	Ø34ØØ	FDB	\$Ø3Ø3
31A3	Ø3Ø3	Ø341Ø	FDB	\$Ø3Ø3
31A5	Ø3Ø3	Ø342Ø	FDB	\$Ø3Ø3
31A7	Ø3Ø3	Ø343Ø	FDB	\$Ø3Ø3
31A9	Ø4Ø4	Ø344Ø	FDB	\$Ø4Ø4
31AB	Ø4Ø4	Ø345Ø	FDB	\$Ø4Ø4
31AD	Ø4Ø4	Ø346Ø	FDB	\$Ø4Ø4
31AF	Ø4Ø5	Ø347Ø	FDB	\$Ø4Ø5
31B1	Ø5Ø6	Ø348Ø	FDB	\$Ø5Ø6
31B3	Ø6Ø6	Ø349Ø	FDB	\$Ø6Ø6
31B5	Ø7Ø7	Ø35ØØ	FDB	\$Ø7Ø7
31B7	Ø8Ø8	Ø351Ø	FDB	\$Ø8Ø8
31B9	Ø9Ø9	Ø352Ø	FDB	\$Ø9Ø9
31BB	ØAØA	Ø353Ø	FDB	\$ØAØA
31BD	ØBØC	Ø354Ø	FDB	\$ØBØC
31BF	ØCØD	Ø355Ø	FDB	\$ØCØD
31C1	ØDØE	Ø356Ø	FDB	\$ØDØE
31C3	ØF1Ø	Ø357Ø	FDB	\$ØF1Ø
31C5	1Ø11	Ø358Ø	FDB	\$1Ø11
31C7	1212	Ø359Ø	FDB	\$1212
31C9	1314	Ø36ØØ	FDB	\$1314
	2ØØØ	Ø361Ø	END	START

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