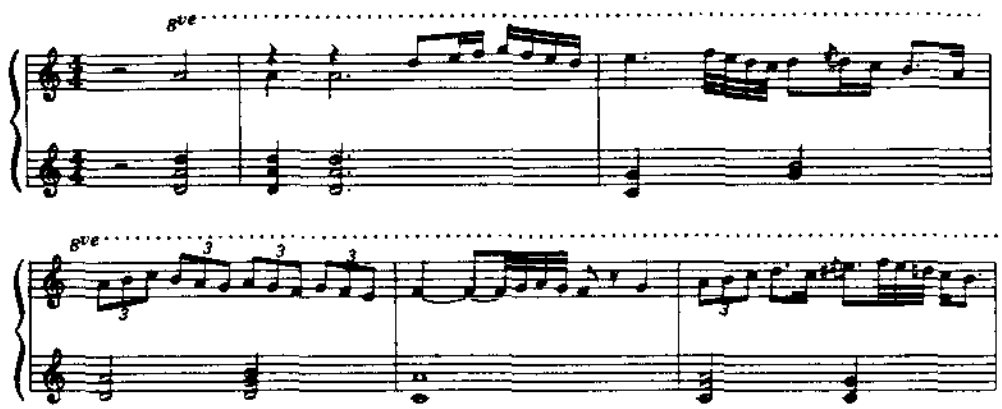
REVISED

POKEY PLAYER



SONG EXCHANGE: The author would appreciate copies of any songs you may compose with POKEY PLAYER and PAGE 6 will exchange disks containing songs composed or transposed by you. A disk containing your songs may be exchanged for a) a new disk containing approximately 30 all new POKEY PLAYER songs or, b) any disk from the PAGE 6 LIBRARY of Public Domain programs. Please send your disk, indicating your choice of exchange to

PAGE 6, P.O.BOX 54, STAFFORD, ST16 1DR

The author forgoes any royalties on POKEY PLAYER in order that the program may be distributed at low cost but appreciates in return your co-operation in helping to build up a library of POKEY PLAYER songs.

REVISED POKEY PLAYER

by Craig Chamberlain 1/24/84

DOCUMENTATION

PART FIVE
 The Compiler

PART SIX
 The Vmerge Program

PART SEVEN
 Advanced Features
 Repeats
 White Noise
 Detuning

PART EIGHT
 Advanced Music Reading
 Accidentals Revisited
 Key Changes
 Octave Offsets
 Double Dots
 Triplets
 Time Signatures
 Tempo Changes
 Dynamics

PART NINE
 The Dynabyte Program

QUICK REFERENCE

Editor Keys
CTRL-INSERT insert a note
CTRL-DELETE delete a note
 CTRL-CLEAR erase current voice
          B move to beginning of voice
          E move to end of voice
          M create measure marker
        TAB search for measure marker
          T set tempo
          P set noise and volume parameters
          R repeat beginning or end
          O frequency offset
          H halt
          L load a source file
          S save a source file (use .S extension)

Compiler prompts
  INPUT DEVICE: D:filename.Sn where n is 1, 2, or 3
 OUTPUT DEVICE: D:filename.Vn
   COMPILATION: E: to send to screen editor
                P: to send to printer
                (press only RETURN for no report)
PRIMARY/SECONDARY (P/S)
 S for voice one or two
 P for voice three

REVISED POKEY PLAYER DOCUMENTATION PART ONE
by Craig Chamberlain 1/24/84

INTRODUCTION

Have you ever wanted to show your computer buddies that your ATARI computer can do more than just play games? Have you ever wondered if your computer's sound generators could do more than make explosion sounds? Have you ever had the desire to compose your own music, but didn't want to learn an instrument? Have you ever been interested in electronic music but didn't want to spend several dollars on hardware? Or, have you ever tried to use the Atari MUSIC COMPOSER cartridge but have given up in disgust due to its many limitations?

Of the three special chips in the ATARI computers, the one that produces sounds (called POKEY, for POrt and KEYboard controller) is the most overlooked and underused. The POKEY is a rather versatile chip, being used by ATARI not only in their home computers, but in their arcade games as well, such as Missile Command. Yet, with few exceptions, the only sounds one ever hears from this chip are explosions and special effects for outer space shoot-em-up games. Isn't it about time somebody put POKEY through its paces?

PRESENTING... POKEY PLAYER

Enter POKEY PLAYER, a music editing and playing utility for ATARI home computers. This music system is designed to allow full access to the wide variety of sounds that can be generated by the POKEY chip. Using POKEY PLAYER, it is possible to produce music of an appreciable quality.

FEATURES OF POKEY PLAYER

POKEY PLAYER has special features not found in commercially available music programs:

* A range of eight octaves is available.
* The joystick is used to enter and edit notes.
* Notes are displayed in two forms; on a grand staff, and as piano keys.
* Each note has an automatic decay for a nicer sound.
* The tempo can be changed while a piece is playing.
* White noise can be used to produce percussion effects.
* An average of only one byte is used for each note. Music files are extremely compact.
* Repeats can be used for note duplication without using extra memory.
* Songs created with POKEY PLAYER can be merged with BASIC programs.

A BRIEF COURSE IN ELECTRONIC MUSIC

To fully appreciate the capabilities of POKEY PLAYER, it is necessary to have an understanding of how electronic music works.

When your ear hears a sound, it is actually detecting vibrations. The rate of vibration is called the frequency and is what determines the pitch of a sound. In a musical instrument, a metal string, reed, stretched membrane, or air in a tube is the thing that is vibrating, and the player usually has a method for changing the frequency.

But sounds are not so simple. Further analysis reveals that there are different kinds of vibrations. As when viewed with an oscilloscope, vibrations have another characteristic called a waveform. Square, triangle, and sawtooth are common waveforms. The waveform is one thing that distinguishes the sound produced by a flute from the sound produced by a violin, even when the two instruments are playing the same note.

There is just one other essential characteristic remaining; volume. As a string is plucked or

air is blown, the volume changes over a short period of time. This pattern of changing volume levels is called an envelope, and is usually divided into four parts called the attack, decay, sustain, and release. The attack describes how quickly a sound reaches the peak volume and then decays to a sustain level, whereas the release tells how the volume fades away.

The frequency, waveform, and envelope are all essential parts of a note, and a sequence of notes creates music. Electronic music is merely a method of producing these qualities of sound by electronic means, and a device which does this is called a synthesizer. Theoretically, it is possible for a synthesizer to imitate any musical instrument, or to produce sounds never heard before.

Although the actual process is much more complicated than described here, some individuals have made some incredible accomplishments in the field of electronic music. The first significant record of electronic music was Switched - On Bach by W. Carlos. Other notable names are Tomita and Synergy.

HOW ATARI COMPUTERS MAKE SOUNDS

The POKEY chip, which handles serial communication and keyboard decoding, also contains four countdown timers which can act as sound channels. Each channel can have its own frequency, noise type, and volume.

The noise type is sometimes incorrectly called the distortion, and there are six different types. Noise type ten is the most commonly used and produces a pure, square wave tone. Other noise types can be used for white noise and other special effects. Sawtooth and triangle waves are not available.

Sixteen volume levels, including no volume, are possible. Each channel continually produces its sound, so duration must be controlled by the user.

For more information, see chapter seven of De Re Atari, or in the HARDWARE MANUAL, chapter two, part B, and chapter three, part F.

RUNNING THE PLAYER PROGRAM

To hear an example of what the POKEY chip can do, run the program named PLAYER by typing RUN "D:PLAYER" in BASIC. A directory of all music files on the disk will be listed on the screen in four columns. Music files are those which have a .V filename extension. In response to the prompt YOUR REQUEST? you should type the name of the song you want to play. You do not have to type the .V extension. The song will load, the full title and credit information will be printed, and the song will start playing.

YOUR REQUEST? GMF

FUGUE IN G MINOR
J.S. BACH
COURTESY ROBERT HIGGINS

When the song is finished, you will be prompted for another selection. Here you would again enter a song name to load and play another song.

When entering a song name, you do not have to type all of the letters in the name. You only have to type the first few letters, enough to distinguish the song name from any others that may be on the disk.

If the requested file is not on the disk, the PLAYER will tell you that it does not know that song, and will ask for a new selection.

If you press only RETURN in response to the song name prompt, the PLAYER will print a new directory. This is useful if the old directory has scrolled off the screen, or if you want to switch disks.

To make a song stop playing early, hit any key on the keyboard. The PLAYER will abort the current song and prompt you for a new selection.

To end the program, press System Rest. The Break key has been disabled.

The demonstration tunes cover a wide variety of music, from classical pieces to current hits. We hope you enjoy listening to the music produced by POKEY PLAYER.

REVISED POKEY PLAYER DOCUMENTATION PART TWO
Craig Chamberlain 1/24/84

CREATING MUSIC WITH POKEY PLAYER

POKEY PLAYER is a lot more than just a music playing program. It is a complete system for entering and editing music. The Player is accompanied by the Editor, Compiler, and Vmerge programs. Using these programs, you can enter songs straight from standard sheet music, or compose your own tunes.

FUNDAMENTALS OF MUSIC THEORY

Although the Editor has been designed to make it as easy as possible to enter a song from sheet music, a minimal understanding of elementary music theory is necessary. The purpose of this part of the documentation is to present the fundamental concepts that will help you get started.

NOTATION

If a song is good, the melody will stick in your mind, and you may find yourself humming the tune after it is done playing. Sometimes a song can be so good, you can't get it out of your mind. By having heard the song, you have learned it and can play it yourself. Songs such as Indian tribal ceremonies have been passed from generation to generation in this way. However, as songs get longer and more complex, this method of communicating a song becomes less reliable. This is when it is necessary to make a permanent copy of the song on paper, which is the purpose of sheet music. Today, orchestras can faithfully reproduce the great symphonies of Beethoven. These symphonies have survived for two centuries only because they were written on paper.

To express music on paper, a special form of notation has been developed. This notation is capable of describing every facet of a piece of music, from general things such as the order in which to play the notes, to specific things such as the style in which they are to be played.

(example)

Each group of five horizontal lines is called a staff. At the left edge of each staff is a clef symbol. The clef symbol for the top staff is called a "treble" clef, and the clef symbol on the bottom staff is a "bass" clef. Together, the two staves form a "grand staff." The grand staff is used for displaying notes.

In the following text, the different characteristics of notes are introduced one at a time. As each characteristic is discussed, the method for expressing it in notation is also shown. Admittedly, music theory is an extremely complicated subject. The text that follows is a simplified explanation of the essential concepts, and is not intended to be a complete treatment. However, once you understand this part of the documentation, you should be able to read a simple piece of sheet music.

PITCH

Sound is produced by a vibrating object. Vibrations pass through the air to reach your ear. If something is moving, its motion can be measured. Frequency is the measure of number of vibrations per unit of time. The most common method of specifying a frequency is in terms of vibrations per second. Such a measurement is indicated by the units Hertz, abbreviated Hz.

The frequency of a sound is detected by your ear as a pitch. Higher pitches are produced by

higher rates of vibration. Usually, the smaller an instrument, the higher the pitches that it produces. A piccolo produces very high pitches, whereas a tuba produces very low pitches.

A wide range of frequencies can be detected by the human ear, however, only frequencies occurring at specific intervals are commonly used in music. Let's start with one of these pitches and label it C. This pitch has a frequency of 261.63 Hz. The sequence of pitches continues, with pitches at the following intervals being named D, E, F, G, A, and B.

```
B 493.88 Hz
A 440.00 Hz
G 392.00 Hz
F 349.23 Hz
E 329.63 Hz
D 293.66 Hz
C 261.63 Hz (start here)
```

When you listen to the sequence of pitches in order, they form what is called a scale, but the scale will seem incomplete. One final note, after the B, is needed to complete the scale. This note happens to be another C, related to the earlier C, but at a higher pitch. (The actual mathematical relationship is that the new C occurs at 523.25 Hz, exactly twice the frequency of the first C.) It doesn't stop here, though. There is another D after our new C, and a second E after the new D, and so on. In fact, the scale repeats several times, both above and below the original C.

```
D 1174.70 Hz
C 1046.50 Hz
B  987.77 Hz
A  880.00 Hz
G  783.99 Hz
F  698.46 Hz
E  659.26 Hz
D  587.33 Hz
C  523.25 Hz
B  493.88 Hz
A  440.00 Hz
G  392.00 Hz
F  349.23 Hz
E  329.63 Hz
D  293.66 Hz
C  261.63 Hz (original C)
B  246.94 Hz
A  220.00 Hz
G  196.00 Hz
F  174.61 Hz
E  164.81 Hz
D  146.83 Hz
C  130.81 Hz
B  123.47 Hz
```

The scale repeats with each C. By examining one sequence, from one C to the next, you will see that it consists of eight pitches. Collectively, these eight pitches are called an "octave." To distinguish this set of pitches from the next, the first set is said to occur one octave lower than the second set.

Just as the different pitches in an octave are labeled, so are the different octaves. However, instead of using a letter of the alphabet, a number is used. The piano key for the original C is found at about the middle of the piano keyboard. This C is called "middle C", and begins octave number four. Other octaves are numbered relative to the octave containing middle C. The octave immediately above octave four is octave five. The octaves which are of the most use musically are octaves 0 to 7.

In music notation, the pitch value of a note is represented by its vertical position when drawn on a staff. C5 is indicated by placing the note between the second and third lines of the treble staff. The next higher pitch, D5, is indicated by placing the note above the position for C5, except that this time the note is placed on the line. The positions for all notes alternate between being on a staff line or between staff lines, for the entire grand staff.

(example)

One special case is middle C. The staff line for C4 is placed half way between the treble and bass staves. The pitches around middle C must take this variation into account. The separation of the two staves creates some space used by messages and special symbols that give additional information to the performer.

Another special situation is when a note is so high or low in pitch that it goes off the grand staff. In such instances, additional staff lines, called leger lines, are added. The pitch of notes drawn on leger lines is still determined in the normal way, by counting staff lines and seeing whether the note is placed on or between lines.

By using the grand staff and leger lines, eight octaves (octaves 0 to 7) can be displayed.

ACCIDENTALS

Eight octaves, each containing seven different pitches, would seem to make a total of 56 pitches. Actually, there are some intermediate pitches between some of these notes. These are called accidentals.

```
          C
          B
A sharp     B flat
          A
G sharp     A flat
          G
F sharp     G flat
          F
          E
D sharp     E flat
          D
C sharp     D flat
          C
```

A note is sharp if its pitch is half a step above its normal pitch. A note is flat if the pitch is a half step below the normal pitch. Notes that are not sharp or flat are said to be "natural." The accidental pitches correspond to the black keys on a piano, whereas the natural notes are represented by white keys.

Two important observations should be made. First, every sharp note is equivalent to a flat note. C sharp and D flat both denote the same pitch. The difference lies in your viewpoint,

whether the intermediate pitch is half a step above C or half a step below D. The other important point is that not all notes can have a corresponding sharp or flat value. There is no intermediate pitch between E and F, or between B and C. If someone talks about the note E sharp, they are really talking about F, because the next step above E is F. Likewise, F flat is the same thing as E. This works in a similar way for the notes B sharp and C flat. Fortunately, note names like these are not used very often.

By convention, accidentals are always expressed only in terms of sharps or flats, never in combinations of both. If you want to talk about the pitches G sharp and E flat, you would either talk about G sharp and D sharp, or A flat and E flat.

Thus far we have been using the words "sharp" and "flat" for accidental notes. Another way to indicate that a note is sharp or flat is to use a special symbol. The symbol for a sharp note looks like a slanted pound sign (#). The symbol for a flat note looks something like a lowercase letter B (b).

To show that a note on the grand staff is a sharp or flat note, the appropriate accidental symbol is placed just before the note.

(example)

Including the accidentals, one octave consists of twelve different pitches. With eight octaves, our total is now 96 different pitches. Practically every song ever written uses only notes coming from this palette of 96 pitches.

KEY SIGNATURES

Just because there are 96 pitches available, does that mean that each one will be used in a song? No; a song may not even play in every octave. Even within a particular octave, only a subset of the twelve pitches are used. The selection of which notes are used is determined by the key in which the music is written.

We introduced the topic of pitch by starting with a C scale. This is a sequence of notes, starting on C, that continues for one octave. Let's examine the relationship of these notes to the twelve in the entire octave. If the distance between each of the twelve pitches is called a half step, the sequence of notes forming the C scale is determined by the following steps: whole, whole, half, whole, whole, whole, half, where a whole step equals two half steps.

Now apply that sequence of steps again, but this time start the scale at the note A.

A
G#
F#
E
D
C#
B
A (start here)

This scale contains three sharp notes, as opposed to the earlier scale which contained none. The sharp notes replaced their natural counterparts. This scale is said to be written in the key of A. A song written in the key of A will normally use only this set of pitches in each octave. This means that we are back to a situation where we only have to deal with seven pitches per octave.

You can start a scale on any note, and for every starting note, there is a different combination of sharp or flat notes that are used. Here is another example, this time using flats.

```
Bb
A
G
F
Eb
D
C
Bb (start here)
```

This is the key of B flat. The notes were determined by using the sequence of half and whole steps given earlier. The key of B flat contains two flat notes, B flat and E flat. The notes B natural and E natural will not normally be used by a song written in the key of B flat.

Here is a complete listing of all of the keys. The keys with less than five sharps or flats are the ones used most often.

KEY	NOTES								SHARPS/FLATS
C	C	D	E	F	G	A	B	C	0
G	G	A	B	C	D	E	F#	G	1# (F#)
D	D	E	F#	G	A	B	C#	D	2# (F#,C#)
A	A	B	C#	D	E	F#	G#	A	3# (F#,C#,G#)
E	E	F#	G#	A	B	C#	D#	E	4# (F#,C#,G#,D#)
B	B	C#	D#	E	F#	G#	A#	B	5# (F#,C#,G#,D#,A#)
F#	F#	G#	A#	B	C#	D#	E#	F#	6# (F#,C#,G#,D#,A#,E#)
C#	C#	D#	E#	F#	G#	A#	B#	C#	7# (F#,C#,G#,D#,A#,E#,B#)
F	F	G	A	Bb	C	D	E	F	1b (Bb)
Bb	Bb	C	D	Eb	F	G	A	Bb	2b (Bb,Eb)
Eb	Eb	F	G	Ab	Bb	C	D	Eb	3b (Bb,Eb,Ab)
Ab	Ab	Bb	C	D	Eb	F	G	Ab	4b (Bb,Eb,Ab,Db)
Db	Db	Eb	F	Gb	Ab	Bb	C	Db	5b (Bb,Eb,Ab,Db,Gb)
Gb	Gb	Ab	Bb	Cb	Db	Eb	F	Gb	6b (Bb,Eb,Ab,Db,Gb,Cb)
Cb	Cb	Db	Eb	Fb	Gb	Ab	Bb	Cb	7b (Bb,Eb,Ab,Db,Gb,Cb,Fb)

If you study the charts carefully, you will notice some patterns. For example, each key that contains sharp notes contains F#. The key of G has F# as its only sharp note. The key of D keeps the F# but adds C#. Each successive key adds one more sharp note, while retaining all of the other sharp notes from before. This pattern works in the same way for keys containing flat notes, starting with the note Bb.

You can determine the key in which a piece of music is written by counting the number of sharp or flat symbols near the clef symbols on the grand staff. If no sharp or flat symbols appear there, the music is written in the key of C. If one sharp symbol is displayed, the piece is written in the key of G. Two sharp symbols mean that the key of D is to be used, and so on. Likewise, one flat symbol indicates the key of F, two indicate the key of B flat, on up to 7 flat symbols, which indicate the key of C flat.

Just as the number of sharp or flat symbols is important, so is their position. The sharp symbol for F# is always placed on the line that designates note F. Furthermore, when a sharp symbol is put next to the clef symbol, it has the effect of automatically placing a sharp symbol in front of every note on that line. A sharp symbol on line F means that all notes placed on the grand staff in F positions are to be played as F sharps. This saves a lot of work when writing music, because it is no longer necessary to write a sharp symbol in front of every F note. Of course, the same is true when flats are used. A flat symbol placed near the clef on the line for B means that all B notes should be played as B flats.

Here are some examples of key signatures. Since all keys that contain sharps contain F#, all of these keys have a sharp symbol at the F position. Each successive key adds a sharp symbol at a new position while retaining all the old ones. Also notice that a sharp or flat on one line affects not only the notes on that line, but the corresponding notes in the octaves above and below, as well.

(examples)

DURATION

The vertical position of a note on the grand staff determines its pitch. The horizontal direction of the staff indicates time. A sequence of notes is played in order from left to right, just as text is read from left to write. To keep the notes playing at an even speed, one note is played every beat. By putting the pitches together in a pleasing order, you will have created a melody, which is the basis for a song.

Pitch, however, is only one major characteristic of a note. Another important quality of a note is its duration. In a song, notes are not always played at the rate of one note every beat. Sometimes a note may be played for two beats. Other times, two notes might be played within the span of one beat, meaning that each note is half a beat in length. Thus, every note on the staff is going to have to specify not only its pitch, but its duration as well, in terms of beats.

The duration of a note is indicated by its shape. The standard note we have been using thus far is formally called a "quarter note," and is drawn with a stem and a filled in oval at the bottom. A quarter note corresponds to a duration of one beat. Twice that length, two beats, is indicated by a half note, which looks like a quarter note except that the oval is not filled in. Twice the length of a half note is a whole note, which plays for four beats and looks like a half note without a stem. In the other direction, for durations less than one beat, the symbol for a quarter note is used, but flags are added at the top of the stem. An eighth note plays for half a beat and has one flag. A sixteenth note has two flags. Four sixteenth notes are equal in duration to one quarter note. Thirty second and sixty fourth notes do exist, but they are not used very often.

The following combinations are all equivalent in duration to one whole note.

(examples)

One convention in displaying durations less than one beat is to combine notes of equal duration in sets. Two eighth notes can be drawn by extending the flag from the first one to the top of the stem of the second one. This can also be done with sixteenth notes, except that two lines will be connecting the tops of the stems, because sixteenth notes have two flags.

(example)

Notes can even be drawn upside down. This is done only when the notes would appear near the top of a staff. The oval portion of the note stays in the same place, so the pitch is not affected. Drawing a note upside down does not affect its duration, either.

DOTTED NOTES

With just a few different durations, it is possible to create a variety of different rhythms, but there are still some durations that cannot be expressed using only the notes introduced so far. For example, how do you show that a note should be played for three beats? Situations like this require the use of dotted notes.

When a dot is placed after a note, it means that the note should be played for one and a half times the normal duration of the note. Given a dotted half note, the half note portion is two beats, and half of that is one beat, for a total of three beats. A dotted whole note plays for six beats (four beats for the whole note and two beats for the dot). And a dotted quarter note? That plays for one and a half beats.

Using the new dot, here are some more note combinations that total four beats.

(examples)

Notice that the dot always appears to the right of the note. If you see a dot placed above or below a note, it has a different meaning, and does not affect the note's duration.

MEASURES

A song is just a long sequence of notes of different pitches and durations. To make it easier to deal with pitches, they are separated into groups called octaves. Likewise, to make it easier to work with a sequence of notes, the notes are often divided into groups called measures, with each measure consisting of four beats.

In sheet music, a measure is formed by placing a vertical line between each group of notes on the staff.

(example)

Measures are mainly used for purposes of organization and reference. It is much easier to refer to a note as being the second note in measure number 23 than it is to refer to the one hundred forty seventh note.

The important point about measures is that each measure must have the same total duration.

TEMPO

One final aspect of duration remains to be discussed. We have seen that the length of a note is expressed in beats, and that notes can be organized into groups called measures that all have the same number of beats. The question is, how long is a beat?

A beat is a unit of time. The shorter the amount of time for each beat, the faster they will occur. The rate at which the beats occur is called the "tempo." The faster the tempo, the more quickly the notes are played. At a slower tempo, each beat lasts for a longer amount of time, and the beats will not happen as fast. For a fixed amount of time, say one minute, there will be more beats at a fast tempo than there will be at a slow tempo. The relationships of quarter notes to half notes and other notes still hold; a half note will always be longer than a quarter note. It's just the actual time lengths that change.

The standard method of measuring a tempo is to specify the beats per minute. An average

tempo is about 100 beats per minute. A tempo of 60 means that there will be one beat every second, which is rather slow. A tempo of 150 is more than two beats every second, which is pretty fast.

The tempo is a very important part of a song. A beautiful melody can be ruined if it is played too fast or too slow. Therefore, sheet music usually indicates the proper tempo. At the top of the sheet music you should find the letters M.M. followed by a number. This number indicates the beats per second, and defines the tempo that should be used in playing the song.

(example)

An alternate way to show the tempo is to replace the M.M. with a quarter note and an equal sign. The quarter note is used because it represents one beat. Either way works just as well.

(example)

Using a number for the tempo is convenient because it can be used when setting a metronome. Yet another method of specifying the tempo is to use a word such as "adagio" or "allegro." Here is a listing of the most common words used to indicate tempo, in order from slowest to fastest:

lento	very slow
grave	slow, solemn
largo	broad
adagio	leisurely
andante	walking
andantino	a little faster walk
moderato	moderate
allegretto	rather fast
allegro	fast
vivace	lively
presto	very fast
prestissimo	as fast as possible

These values may be modified by one of the following words:

molto very
meno less
piu more

The tempo marking "moderato" indicates medium speed, which roughly corresponds to M.M. 100.

RESTS

Pitch and duration are the two most important parts of a note. There is a kind of note, however, which has only duration and no pitch. It is called a rest. For the specified amount of time, no tone is produced.

There is a different rest symbol for each duration. Because the idea of pitch does not apply, the vertical position of a rest does not matter, so it is usually placed in the middle of the staff. A whole rest is drawn as a small block placed right below the second staff line. A half rest looks the same except that the block is placed on top of the third staff line. A

quarter rest is a funny little symbol that defies description. Eighth, sixteenth, and thirty second rests are all drawn as stems with the proper number of flags but no ovals.

(examples)

Here are some combinations of notes and rests. They have been divided into measures to show that each group has a total duration of four beats.

(examples)

TIES AND SLURS

Another special symbol is called the "tie" symbol. Two notes are tied together when connected by a symbol that looks like a curved line or "arc." The tie means that the two notes are to be played together as one long note, with no break in volume. Thus, two quarter notes tied together will play just like a half note.

(example)

The reason for using ties is that the effect of a tie can extend across one measure and into another. In the following two sequences of notes, each sequence will sound the same when played, but the first one cannot be divided into measures.

(example)

The next example demonstrates using a tie to create a note that is five beats long.

(example)

Another application of the tie symbol is to connect notes of different pitches. In this use, the tie is called a "slur" and may be used within a measure as well as between two measures. Playing two quarter notes slurred together is like playing a half note that changes its pitch half way through playing.

(example)

Sometimes a very long tie symbol is used over a long stretch of notes. This produces a smooth, "legato" effect when the notes are played.

VOLUME

Yet another major characteristic of a note is its volume. Some parts of a song can be emphasized if they are played very loud. Other parts may be subdued by being played very quietly. The level of loudness or softness of a piece of music is referred to as "dynamics."

Dynamics are indicated on sheet music by letters that appear between the two staves of the grand staff. These letters are listed below, in order from loud to soft.

```
fff (fortississimo)
 ff (fortissimo)
  f (forte)
 mf (mezzo forte)
 mp (mezzo piano)
  p (piano)
 pp (pianissimo)
ppp (pianississimo)
```

These volume levels range from very loud (ff) to very soft (pp). Extremes such as ffff or pppp are not used very often.

ENVELOPE

Dynamics describes the general volume of a piece of music, but it does not describe the changes in volume that occur during the duration of a single note. When the note first starts playing, the volume must increase from no volume to the peak volume established by the dynamics. The speed at which this volume is reached is called the "attack rate." The volume will stay at this level, called the "sustain level," for most of the duration of the note. Towards the end of the note, the volume will begin to fade away, at a speed called the "release rate." These changes in volume over the course of the note are referred to as the "envelope" of the voice.

The envelope is a very important aspect of playing notes. If the volume did not fade away at the end of a note, you would not be able to distinguish several short notes of the same pitch played together. The break in volume is necessary to prevent them from sounding like one long note.

Different instruments have different characteristic envelopes. A string instrument produces sound when the bow starts moving across the string. This is the attack. As long as the bow keeps moving, the instrument keeps producing a tone at the sustain level. When the bow stops, the tone will fade away as the string stops vibrating. The process works similarly for a wind instrument. A snare drum produces sound right when it is struck, but begins to release rather quickly as soon as it reaches the sustain level. A gong, on the other hand, has a very slow release rate.

Standard sheet music does not specify an envelope for a voice. Rather, the sheet music indicates which instrument the music is written for. The person playing the music on a computer must then choose an envelope which closely approximates the instrument to be emulated.

WAVEFORM

The "timbre" of a sound is what distinguishes a middle C played on a saxophone from a middle C played on a cello. This quality of a sound depends on the type of vibrations producing the sound. The most common kinds of vibration are square wave, triangle wave, and sawtooth (or "ramp") wave. The type of vibration that is producing a tone is called the "waveform" of a voice.

There is another kind of vibration which has no pattern, but is completely random. This is called "white noise," and sounds like the snow on a television. The name is derived from the fact that white noise consists of all frequencies played randomly, just as white light consists of the three primary colors. Even though it has no specific shape, white noise is usually treated as a waveform.

Like the envelope, the waveform is another factor that distinguishes notes played on one instrument from notes played on another. A flute produces a triangle wave, whereas brass instruments produce sawtooth waves. As before, sheet music does not say which waveform is to be used. It is the responsibility of the person entering the music to choose the waveform appropriate to the instrument being emulated.

SUMMARY

The most important aspects of a note are its pitch and duration. Pitches occur in groups called octaves. Each octave contains the pitches labeled C, D, E, F, G, A, and B, plus some

intermediate pitches called accidentals. Only some of these pitches in each octave are used, depending on the key signature of the music. Durations are specified in terms of beats, and are called whole note, half note, quarter note, and so on down to sixty fourth note. The rate at which the beats occur is called the tempo, and is measured in terms of beats per minute. A note which plays for a duration but which produces no tone is called a rest. Notes are organized into groups of equal total durations called measures. Notes can be tied or slurred. The general volume level of a piece of music is specified by dynamics. The envelope describes the changes in volume over the duration of each note. The waveform of a voice describes the kind of vibration that is producing the tone. Different instruments have characteristic envelopes and waveforms.

Notes are shown on a grand staff that consists of the treble and bass staves. Each staff has its own clef symbol. Pitch is indicated by the vertical position of a note on the grand staff. The note may be drawn on a staff line, or between staff lines. A sharp or flat symbol may be placed immediately before the note to indicate an accidental. A key is indicated by placing sharp or flat symbols near the clef symbol. Durations are indicated by the shapes of the notes. Placing a dot after the note means that its duration should be one and a half times the normal duration. Measures are indicated by a single vertical line that crosses the staff lines. The tempo is indicated by an M.M. marking at the beginning of the music. Rests are indicated by special symbols, one for each duration. An arc type symbol connecting two notes is used to indicate a tie or slur. Dynamics are indicated by letters that appear between the two staves. The instrument is identified at the top of the sheet music.

REVISED POKEY PLAYER DOCUMENTATION PART THREE
by Craig Chamberlain 1/24/84

MULTIPLE VOICES

We have shown you the essential characteristics of individual notes, and have shown how notes can be combined into groups called measures. The music can then be sung or played on an instrument. The next step is to have several voices or instruments playing at the same time.

A set of notes for one singer or one instrument is generally referred to as one "voice." With two voices playing simultaneously, one voice can play a melody while the other voice plays a bass part to give a little more body to the song. If a third voice is added, it can be used for percussion effects such as drums or cymbals.

Each voice is independent of the others, and can play its own notes of different pitches and durations. This brings to light only one problem; there must be a means of keeping the voices synchronized. They should start together, and end together. Fortunately, the concept of tempo and the use of measures solves this problem. The voices may be independent, but one thing they must have in common is the tempo. The tempo establishes a beat which all voices can follow. The notes in each voice are divided into measures. Then, even though the durations within a measure may differ for each voice, at least the voices will always be on the same measure at any given instant.

(example)

The horizontal direction of the grand staff corresponds to time. Because multiple voices are synchronized according to tempo, it is possible to represent more than one voice on just one grand staff. Within each measure are drawn the notes for all of the voices. It is a rather simple matter to determine which notes go with which voice. Usually, the topmost notes are for the first voice, the notes below those are for the next voice, and so on, with the bottom-most notes being for the last voice.

(example)

CAPABILITIES OF THE POKEY PLAYER MUSIC SYSTEM

Pokey Player can handle up to three voices playing together. Each voice has its own pitch, duration, volume, and waveform. The first two voices, called "secondary" voices, have a five and a half octave range, from C1 to F6. The third voice, which has a full range from C0 to C8, is called the "primary" voice. Durations can range from whole notes to thirty second notes, with optional dots. Volume levels are from 0 to 15, with 15 being the loudest and 0 being "off." The only waveforms supported by the POKEY chip are square wave and white noise. A wide range of tempo choices are available, from 56 to 300 beats per minute. Notes can be tied or slurred. Rests can be used. Finally, notes can be grouped into measures.

MUSIC CREATION PROCESS

To help you enter, edit, and debug music, three programs, Editor, Compiler, and Vmerge, are provided. Music prepared by using these programs can then be played by the Player.

The first step is to create a music source file for the first voice. The Editor lets you enter notes using a joystick. You can insert, delete, and replace notes as needed. When you are done, you save the voice to disk as a music source file.

The next step is to use the Compiler to compile the voice into the more compact size that is

needed by the Player. The compiled file is usually almost half the size of the source file. Another advantage is that errors in the source file can be detected when it is compiled. The Compiler cannot find bad notes, but it will catch notes that go out of range, or measures that do not have the proper number of notes.

The above steps must be repeated two more times, once for each remaining voice. If the music has only one voice, the remaining voices should be filled with rests. When done, you will have three source files and three compiled files. The three compiled files are then combined into one file by the Vmerge program. This file is the one that is played by the Player.

The next three parts of the documentation describe in detail how to use these three programs.

REVISED POKEY PLAYER DOCUMENTATION PART FOUR
by Craig Chamberlain 1/24/84

THE EDITOR

To use the Editor, from BASIC type RUN "D:EDITOR". The screen will be blanked at first, and a little while later a full screen will appear. The Editor is a graphically complex program, using redefined characters, players, and display list interrupts, so it takes a while to initialize. When it is ready, it will play a middle C note.

The first thing you will notice about the Editor is that the screen is divided into different levels. The top level is used for text lines and message prompts. The next level has the word REST on it. This level will be used to enter rests. The main level is where notes are selected. This is the default level, and will be highlighted in a bright white color. The main level displays the current pitch in three different forms; as a note on the grand staff, as a piano key, and as a letter and octave number. The level below the main level is used to specify durations. The next level is used to select a tie or slur. The bottom level contains a box in which entered notes will appear.

USING THE JOYSTICK

The method of using the joystick is as follows:

1) push the stick up or down to move to a different level
2) push the stick left or right to change a parameter within a level
3) press the trigger at any time to enter a note

PITCH

While you are in the main level, pushing the stick left and right changes the pitch. The quarter note on the grand staff will move, the next key on the piano will be indicated, and the written display will change. A full eight octaves is available just by pushing the joystick. Notice that all twelve pitches in an octave are available. Some of the accidentals are labeled as sharps, others are labeled as flats, depending on their most common usage.

Take a moment now to enter a few notes. Just select a pitch and press the trigger. A note will appear in the box in the bottom level, and then scroll to the left. The note looks like a quarter note, which is the current duration, and has the pitch and octave number written above it. As you enter more notes, each one will appear in the box, and all will then scroll to the left to make room for the next one. If you press the trigger twice without changing the pitch, the pitch of the previous note will be used.

DURATION

Move down to the level which shows the durations, and switch to a different duration by pushing the stick left or right. Notice that all durations also have a dot option, except the thirty second note. Now press the trigger. The note that appears in the box will be in the current pitch, but with the new duration.

You do not have to be in the main level to enter a note; a note can be entered from any level. You have to go to the main level only if you want to change the pitch. However, if you are in a level other than the main level when you press the trigger, the Editor will return to the main level after the note is entered.

REST

To select a rest, move up to the line which displays the word REST and push the stick either left or right. The note name in the main level will change to read "RST." Any notes now

entered will be rests. The rest mode stays in effect until canceled. To cancel the rest mode, either move up to the line and push the stick left or right again, or change the pitch while in the main level. Changing only the duration does not affect the rest mode.

TIE/SLUR
The tie/slur mode works a little differently. Like the rest mode, it is selected by moving to the level and pushing the stick either left or right. The word TIE will change color. The major difference is that the tie/slur mode is automatically canceled when a note is entered. To cancel it without entering a note, move the stick to the tie/slur level and push the stick left or right again.

SCROLLING
While entering notes, if you make a mistake, it is easy to go back and correct it. Move to the bottom level, where the notes are displayed, and push the stick to the left. All of the notes will scroll to the right. The note which scrolled off the screen will appear at the left edge, and the most recently entered note will move back into the box. As you continue to scroll, the current pitch and duration, and rest and tie/slur modes, will change to reflect each note that appears in the box. Keep scrolling until the note which needs to be changed appears in the box. Now select the correct pitch, duration, and other features, and press the trigger. The old note will be replaced with the new one. You can now push the stick to the right to scroll back to the end of the voice and continue entering notes.

Due to a bug in the Editor, the note at the far right may not be displayed completely after replacing a note. The note is still there, and will set the parameters correctly when it appears in the box. It's just that part of the note is not displayed. If you still prefer to see the entire note, just scroll it off and back on the screen.

INSERT
If you miss a note and need to insert a note between two others, an insert feature is available. Scroll until you reach the point where a note should be inserted. The note that appears in the box is the one that will be to the right of the note to be inserted. Next, press CTRL-INSERT. The note in the box, and all notes to its right, will scroll to the right, creating an opening in which you can enter a note. If necessary, you can insert several blanks. The only thing you can not do while blanks exist is scroll. You must fill in all the blanks to make the voice complete again before adding new notes at the end.

DELETE
To get rid of extra notes or blanks, press CTRL-DELETE. The note or blank that is currently in the box will be deleted, and the notes to its right will scroll to the left to fill in the gap.

CLEAR
To erase the entire voice, press CTRL-CLEAR. Since this command can be rather destructive if done accidentally, you will be asked for a confirmation. Press Y in response to the prompt. Typing any other key will abort the clear feature.

MOVING TO THE ENDS OF THE VOICE
Often it is necessary to move back to the beginning of the voice. Other times it would be handy to quickly move back to the end of the voice, to continue entering new notes. In these situations, use the B and E keys. Pressing the B key will immediately take you to the first note in the voice. Likewise, pressing the E key takes you to the last note.

MEASURE MARKERS
To help you keep your place in a voice, measure markers are available. Press the M key.

The next measure number will be printed in parentheses at the top of the screen. This number starts out at one. To select that measure number, press RETURN. The measure marker will appear in the box, much like a normal note, and scroll to the left. The next time that you use the M key, the default value will be one greater than the last measure number. Measure numbers from 0 to 511 are available. If you want a measure number other than the default value, type the desired number before pressing RETURN. To abort the feature, enter the number 512.

MEASURE SEARCH

The real advantage to using measure markers is that the Editor can search for a specific measure marker and move to that point in the voice. This is like the B and E keys, except that now you can quickly move to someplace in the middle of the voice. To search for a measure, press the TAB key. Enter the measure number when prompted. The Editor will search the voice from the beginning until it finds the requested measure. If the measure is found, the Editor will move to that marker. If the Editor does not find the measure before it reaches the end of the voice, no action will be taken. To abort a measure search, press only RETURN in response to the measure number prompt.

TEMPO

The tempo command is usually the first thing in a voice. When you press the T key, the top level will ask you for a tempo number. The available tempo selections are listed here.

KEY	M.M.	
0	56	
1	60	(no thirty second note)
2	64	
3	69	(no thirty second note)
4	75	
5	82	(no thirty second note)
6	90	
7	100	(no thirty second note)
8	113	
9	128	(no thirty second note)
A	150	
B	180	(no thirty second note)
C	225	
D	300	(no thirty second note)

When you press one of the designated keys, the Editor will display the M.M. value and the restrictions, such as whether a thirty second note is allowed. Notice that some tempo selections do not support the use of the thirty second note. Once you have chosen the tempo you want, press RETURN to enter the command. Press any key other than 0 to 9 or A to D and then RETURN to abort this feature.

NOISE AND VOLUME PARAMETERS

Press the P key to select the command that sets the noise and volume of the voice. The first prompt asks you for a noise number. For now, use noise ten, which produces a pure tone and is the default noise for the voice if none is specified. After you enter the number 10, you will be asked what volume level you want. The default volume level for a voice is six. For best results, do not exceed level eight if all three voices will be playing at the same time. Volume levels beyond ten are not recommended in any situation. When you type the volume number and press RETURN, the command will be entered. Press only RETURN to abort this feature.

VOICE END

The end of a voice requires special handling. First, press the H key to enter a halt command. The command is entered immediately because it has no data values. Then, enter a quarter rest. This ensures that the voice is quiet when the Player stops playing the music. The halt command and the quarter rest are required, in that order, at the end of each voice.

STANDARD VOICE FORMAT

A typical voice will always start with a tempo command. If no tempo is specified, M.M. 100 is assumed. The next command should be the one to set the noise and volume. This command is also optional, and if it is not used, the Player will use noise 10 and volume 6. After these two commands comes a series of measures. Each measure should start with a measure marker. The end of the voice must have a halt command and a quarter rest.

LOADING A VOICE

To see an example of a source file, let's load the voice which has the melody part for the song BLUES. The melody is on the primary voice (voice three) and the disk contains the file BLUES.S3. To load a file, press the L key, and then press D or C, depending on whether you are using disk or cassette. If you are using a disk, you will be prompted for a filename, which would be BLUES.S3 without the D:. When you press RETURN, the file will start to load. If an input/output error occurs, the Editor will print an error message. Otherwise, if the load was successful, the old voice will be cleared and the new source will be in memory. Remember, loading erases the file currently in memory. After the load, the Editor will be pointing at the last note in the voice. Use the B key if you want to examine the voice starting at the beginning.

SAVING A VOICE

If you have entered a new voice and want to save it, or have modified an old source and want to save the updated version, use the save command. This command works just like the load command, except that the file is written from memory to disk or cassette, and the file in memory is untouched.

EXIT

When you are done using the Editor, press System Reset. The Break key has been disabled for your protection.

REVISED POKEY PLAYER DOCUMENTATION PART FIVE
by Craig Chamberlain 1/24/84

THE COMPILER

The purpose of the compilation step is to compact the music file. The advantages of a smaller file are that it loads faster and takes less space on a disk. In fact, you will probably run out of directory entries (the directory can hold a maximum of 64 filenames) before you run out of free sectors.

The Compiler is the only one of the three editing programs that is written entirely in machine code. It cannot be loaded from BASIC. Instead, type DOS to go to the DOS menu, and use item L to load a binary file. Type COMPILER.OBJ in response to the filename prompt. The file will load and automatically start to execute.

If you are loading the Compiler from cassette, turn the computer off, press and hold down the Start key, and turn the computer back on. The computer will beep once, which is your cue to position the tape and press PLAY. Press any key on the computer when you are ready. The file will load and automatically begin executing.

The Compiler will ask you four questions.

```
   INPUT DEVICE:
  OUTPUT DEVICE:
    COMPILATION:
PRIMARY or SECONDARY (P/S)
```

If you wanted to compile the source for voice three of the BLUES song, you would type D:BLUES.S3 for the first prompt. The compiled form of the voice should then go to D:BLUES.V3, which is your response to the second prompt. You must use a filename extender of .V followed by a number if you are working with a disk.

Generation of a compilation report is optional. The advantage of not generating a report is that the compiling will go much faster. If you do not want a report, just press RETURN in response to this prompt. Otherwise, type E: if you want the report to go to the screen editor, or type P: if you want to send it to the printer.

Voices one and two are considered "secondary" voices because they do not support the full eight octave range. Only voice three, which can play notes from C0 to C8, is considered a primary voice. Press the S key if you are compiling voice one or two, or press the P key if you are compiling voice three. As soon as you press the key, the compiling will begin.

Let's examine the information given in a compilation report. You will see a lot of numbers in columns. The first column is the current byte number. This number is incremented every time another byte is compiled, and is useful in advanced applications.

The next number is the running frame count. A frame, also known as a "jiffy," is a unit of time. One frame is exactly one sixtieth of a second. Each duration, from a whole note to a thirty second note, plays for a certain number of frames, according to the current tempo. As notes are played, the total frame count keeps increasing. Special commands like the one that sets the noise and volume do not have a duration, so the running frame count will not change for these commands.

The next two columns are the actual byte value that has just been compiled, printed in

decimal and hexadecimal form. Again, this information is more useful in advanced applications.

After these columns of numbers have been printed, any remaining text depends on whether the Compiler is working on a note or a command. If a note is being compiled, you will see the octave number, pitch, and duration. The pitch is printed as a letter (C to B) and an accidental if there is one. The plus sign is used to indicate a sharp note, and a minus sign means that the note is flat. No symbol is printed for a natural note. Only one letter (W, H, Q, E, S or T) is printed for the duration. If the note is dotted, a letter D will appear further to the right. If the note is tied, a letter T will appear.

Occasionally you will see a byte compiled which says -1 or 2 or some other number in the octave column, and no other information. Sometimes the Compiler produces bytes which are not labeled at all. These bytes are used only by the Player, and you can just ignore them.

Different commands are handled in different ways. The tempo command will be printed as PPTEMP with the M.M. value in parentheses, followed by several unlabeled lines.

The command to set the noise and volume parameters is called PPPARM. The numbers in parentheses are the noise and volume, in that order. This command is followed by two unlabeled lines.

The halt command is printed as PPSTOP. This command does not have any data values.

A measure number gets special treatment. First, the Compiler prints a blank line to separate the measure from the previous one. Then it prints the message MEASURE NUMBER followed by the number of the measure. This makes it easy to quickly locate a specific measure in the report.

When the Compiler reaches the end of a measure, it prints the total number of frames for that measure only. This is an extremely helpful debugging tool. All measures should have the same number of beats, so they should all have the same total number of frames. If you missed a note or perhaps entered one twice, a quick look at the compilation report will tell you this right away.

While compiling, the Compiler checks for one other kind of error. The Editor lets you enter notes from C0 to C8, even if you are working on a secondary voice, which has a smaller range (C1 to F6). If the Compiler finds a note to be out of range when it is compiling a secondary voice, it will stop with an error message.

The Compiler is always watching for standard input/output errors. The most common errors are 138 (device timeout) and 170 (file not found). If an error occurs, the Compiler will print an error message and stop. To rerun the Compiler, press the Start key. The Compiler will automatically rerun when it has compiled a voice without error. To quit the program and return to BASIC, press System Reset.

A sample compilation of BLUES voice three has been provided. Notice that due to a peculiarity in the song, one measure is only two beats instead of four, and the measure frame count reflects that difference.

REVISED POKEY PLAYER DOCUMENTATION PART SIX
by Craig Chamberlain 1/24/84

THE VMERGE PROGRAM

This program takes the .V1, .V2, and .V3 compiled files for one song and combines them into one file. This is done so that the Player only has to load one file. Also, if there were three files for every song on a disk, the available entries in the directory would be used up too fast.

When you run Vmerge, the program will ask you for the music filename. Type only the name of the song, without the D: or any extension. When you press RETURN, the program will load three files, using the specified filename with the extensions .V1, .V2, and .V3. These three files must be on the current disk. Vmerge will then create a fourth file, using the specified filename with an extender of just plain .V.

Even if you want to play just one voice, compiled files for all voices must exist. The way around this problem is to compile a "dummy" file that consists only of rests. For example, if you want to play only the melody line of the BLUES piece, which is on voice three, enter enough whole rests and save them as source files .S1 and .S2.

The last thing Vmerge does is prompt you for text lines. These are optional, and are normally used when you are merging the final version. If you do not want to enter text lines, just press RETURN and the program will end. When text lines are used, the standard format is: one or two lines for the full title of the song, one line identifying the composer, and one line crediting the person who entered the song. Press RETURN an extra time after you have entered the last line of text.

Once the .V file has been completely written and the program ends, the song is ready to be played by the Player. If you need to make changes to a voice, use the Editor to change the source, save the revised version, recompile, and run Vmerge again. You do not, however, have to recompile the other sources that were not changed. Therefore, it is a good idea to keep the three .V files until the song has been completed.

REVISED POKEY PLAYER DOCUMENTATION PART SEVEN
by Craig Chamberlain 1/24/84

ADVANCED FEATURES

The Pokey Player system has a few other special features that are used in advanced applications. This part of the documentation shows you how to reduce the number of notes entered by using repeats, how to use white noise for a percussion effect, and how to do detuning to get another interesting type of sound.

REPEATS

As you listen to a piece of music, you can sometimes hear that a group of measures is played more than once. Repetition occurs often in music, especially in contemporary songs. So that the repeated measures do not have to be written twice, special symbols are used in sheet music to indicate that certain measures are to be repeated. The symbol that marks the beginning of a repeat consists of two vertical lines followed by two dots. The end of a repeat is marked by a symbol that looks almost the same, except that the dots come before the double lines, instead of after them.

(example)

When the music is played and you come to the first repeat symbol, the playing continues as usual. However, when you come to the end of the repeat, instead of continuing to the next measure, playing jumps back to the measure which had the beginning repeat symbol, and continues from that point. When you come to the end repeat mark the second time around, you ignore it and continue with the next measure. Normally a sequence of notes is repeated only once. There are, however, cases where a voice may repeat several times, such as in a bass line.

The Editor has a special command to support repeats, so that you don't have to enter the same notes twice. When you press the R key, the Editor will display a beginning repeat symbol in the top level, and ask you to press RETURN. It will then ask you how many times the sequence of notes is to be played. In a standard repeat, the notes are repeated once, meaning that the sequence is played a total of two times, so you would normally type the number 2. Upon pressing RETURN the command will be entered, and you can continue entering notes. At the end of the repeat, press the R key again. This time the symbol is for a repeat end, with dots to the left of the lines. Press RETURN to enter the command. When the Player later plays this voice, it will play the note sequence the designated number of times.

The number that is entered for the beginning of a repeat can range from 0 to 255. You will probably never need to use values larger than about 30. The number 1 means that the sequence should be played only once, which would seem to make the repeat structure unnecessary. A value of 1 is used only when you are developing a piece of music. If you keep replaying a song to listen for bad notes at the end, you don't want to wait for repeats earlier in the song, so use the number 1 at first and remember to change it to the correct value before you compile the final version. The number 0 should not be used, because it will make the voice repeat forever.

Repeats cannot be nested. Whenever you have a repeat beginning, it has to be later followed by a repeat end before another beginning can be used. It is okay for a voice to contain several repeats; you just cannot have a repeat inside a repeat. However, each voice can have its own repeat, so each one can repeat independent of the others.

When repeats are used properly, there should be one repeat end for every repeat beginning. If the Player encounters a repeat end with no corresponding repeat beginning, it will repeat forever back to the previous repeat beginning. If no repeat beginning has been used at all on the current voice, the Player will repeat forever back to the beginning of the voice.

Occasionally you will find that a repeat has a first and a second ending. This means that one set of notes should be played at the end of the sequence the first time through, and a different set should be played the second time through. The simple repeat structure of the Editor cannot handle this kind of repeat, so in this case you will have to enter some notes twice.

Sometimes you may find a measure that contains nothing but a slash mark with a dot to either side. This is called a "simile," and means that the measure should be played exactly like the preceding measure. Repeats can help out here, too, because it is just as easy to repeat a single measure as it is to repeat a group of measures.

Other forms of repetition include da capo and dal segno. Da capo is indicated in sheet music by the letters D.C., and it means that the playing should jump back to the beginning of the voice and continue from there, this time ignoring all repeats. The playing may be stopped before the end of the music by the use of the word FINE.

Dal segno, identified by the letters D.S., means that playing should jump to the measure marked by a special sign. This sign looks like a slash with dots to either side, passing through a fancy letter "S". Playing continues from this point, and will stop at either the end of the music or at a FINE, whichever comes first.

There is one other symbol that is often encountered when da capo or dal segno has been used. After playing has jumped back to the beginning of the voice or to a particular measure, you may encounter the message "To Coda" followed by a coda symbol. The coda symbol looks like a letter "O" with a cross passing through it. This means that playing is going to jump to another place again, but this time, instead of jumping back, the jump skips ahead. At the end of the sheet music you should find some measures labeled as "Coda," with the coda symbol shown again. Playing jumps to the first of these measures, and continues until the end of the song.

WHITE NOISE

For a percussion effect, such as a snare drum, a voice can be made to produce white noise instead of a pure tone. The Editor command that sets the volume also sets the noise type. The notes F sharp 6 to C7, which are not normally used on a secondary voice, have been reserved for use with white noise. Thus, playing percussion notes involves changing the noise type and playing special notes.

While in the Editor, press the P key to change the noise and volume parameters. Specify noise 8 instead of noise 10. Use a normal volume level. After this command place several notes of short duration, using a pitch such as B6. Eighth note and sixteenth note durations work best. You will still here noise ten pitches as the notes are entered, because the change to white noise is handled only by the Player. By playing a few of these notes interspersed with rests, you can create various interesting patterns. Such a pattern would be ideal for use in a repeat. Even something as simple as a four or eight beat pattern that keeps repeating can add a nice touch to a song.

Different kinds of white noise can be obtained by playing different pitches in the range F sharp 6 to C7, and by using noises 0 or 4 instead of noise 8. To switch back to normal playing, just change the noise back to 10.

Best results are obtained when you use voice one or two. Save the precious primary voice for a melody line which may require the extended range.

The songs BLUES and HBDAY are two examples of how white noise can be used.

DETUNING

Normally, you should never let two voices play the exact same pitch at the same time. When this happens, the two voices can cancel each other out, and no tone will be produced. However, if one of the voices has its pitch adjust up or down a little bit, the two voices will not "lock up," and in fact will create an eerie type effect, something like a slightly out of tune piano. If the two voices then play the exact same sequence of notes, while one voice is still detuned, you will get an interesting kind of sound that can be used to create a special effect.

The one remaining special feature in the Editor is the frequency offset command, which lets you slightly detune a secondary voice. This allows generation of frequencies between the normal half step notes. Press the O key, and enter a number from 0 to 255 in response to the prompt ENTER OFFSET AMOUNT. Usually a small number from 1 to 4 is satisfactory. Using larger values may detune the voice by more than a half step. A value of 1 causes the frequency for the current voice to be decreased just slightly. To increase the frequency, type the number 255 for -1, 254 for -2, and so on. The command will be entered when you press RETURN.

To use detuning, enter some notes into the Editor and save them as one voice. Go to the beginning of the voice, insert the frequency offset command, and save the voice to a different source file. When that voice is compiled, the offset command will be listed as PPOFST, with the offset in parentheses. When the voices are played, you will hear the weird effect that was described earlier.

Like white noise, detuning is a special effect that should be done only on a secondary voice. The frequency offset command will not work properly on the primary voice. One other restriction is that detuning should be done only when playing notes at C3 or above. Notes below C3 are generated in noise twelve (even when noise ten is specified), and noise twelve does not work well with detuning.

To turn off detuning, enter the frequency offset command with a value of 0.

Two songs which demonstrate the detuning effect are HBDAY and NELLIE.

REVISED POKEY PLAYER DOCUMENTATION PART EIGHT
by Craig Chamberlain 1/24/84

ADVANCED MUSIC READING

What is music? Music can be defined in many ways, but one way to describe music is to say that it consists of change - changing pitches, changing durations, changing volumes, and changing instruments. The second part of the documentation discussed these characteristics of music on a simple level. The different pitches, keys, durations, volume levels and waveforms were introduced. This part of the documentation re-examines these same characteristics, but from a broader viewpoint. For example, the same volume level may not be used throughout a song. The volume may change at different places in the music. Or, the tempo might change. Even the key may change sometime during a song. Changes like these may not happen in a simple piece of music, but they certainly do occur in longer, more sophisticated works. Now that you have some experience in using Pokey Player, it is time to look at these more advanced aspects of music. The purpose of the following text is to cover all of the elements of notation that are commonly found in sheet music but which were not discussed in Part Two.

ACCIDENTALS REVISITED

In any octave there are twelve different pitches, including naturals and accidentals. Earlier we said that a song will only use seven of these pitches, according to the current key. Well, this is not always true. Once in a while a song may have to play a note using a pitch that is not in the key. The BLUES piece is written in the key of G, meaning that only one note is sharp (F sharp), but the melody line had to play a C sharp at one instance.

Special exceptions like this are handled by placing an accidental sign immediately before the note that is to be sharp or flat. This accidental overrides the current key signature for that particular pitch.

(example)

Furthermore, the effect of the accidental sign holds true for all following notes of the same pitch. A sharp sign placed in front of a C affects not only that C note but any other C notes that may come afterwards, even if they are in a different octave.

(example)

The changed accidental is not permanent, though, and is canceled at the next measure.

(example)

An accidental sign used in this manner affects only the designated pitch. All other natural and accidental pitches remain the same.

(example)

All of the preceding examples have used sharp notes. A flat symbol can also be used in a measure to change a specific pitch from natural to flat.

(example)

We have shown how to change a natural pitch into a sharp or flat pitch. What about the other direction - removing a sharp or flat from a pitch to make it natural? This can be done

by using a natural sign. The natural sign looks like a square with two legs sticking out. Placed in front of a note, it cancels the sharp or flat for all following notes of the same pitch, but only within the current measure.

(example)

There is one more possibility to be discussed. Although they are not used often, it is possible to have double sharps or double flats. Changing a natural note into a sharp note is done by increasing the pitch one half step. If this is done on a note that is already sharp, the pitch will be bumped up another half step. The symbol to indicate a double sharp looks something like a letter "X".

(example)

Two flat signs are used to indicate a double flat.

(example)

To conclude, there are actually a total of five different accidental signs. In addition to the sharp and flat signs, there is a natural sign, a double sharp sign, and a double flat sign.

KEY CHANGES

Normally, the clef symbols are drawn only at the beginning of a piece of music. They are followed by sharp or flat signs that indicate the key in which the music is to be played. Together, these symbols specify what is called the "key signature."

A piece of music does not have to use just one key for an entire song. If a key signature appears somewhere in the middle of the sheet music, it is indicating a change in the key. Any previous sharps or flats are canceled, and only the sharps or flats specified by the new key signature are to be used.

Sometimes you may see natural signs appearing in a key signature when there is a key change. These natural signs will be placed at the positions which used to have sharps or flats in the previous key. They serve only as a reminder that the accidentals for some notes have been canceled.

Key changes are not as common as volume changes or tempo changes, so they can be easy to miss when reading sheet music. A good suggestion might be to look over the sheet music before entering notes so that you will be expecting a key change if there is one.

OCTAVE OFFSETS

Sometimes a voice may be so low or high in pitch that to write it on a grand staff would require using a lot of leger lines. Rather than use so many leger lines, a common practice is to write the notes one octave lower or higher so that they fit on the grand staff. A special mark informs the person playing the music that the notes are to be played one octave higher or lower. These markings are usually written as 8VA and 8VABA. The 8VA marking, which may be followed by brackets or a squiggly line, indicates that the notes are to be played one octave higher. The 8VABA marking is used in the other case, when notes are to be played one octave lower than written.

(example)

DOUBLE DOTS

A dot placed after a note means that the duration should be increased by one half. Adding a

second dot means that the value of the first dot should be increased by one half. Thus, a double dotted half note is equal in duration to a half note plus a quarter note plus an eighth note. Double dots can be used on other durations, as well.

Because double dotted notes are very rare, they are not directly supported by the Editor. You can simulate them, however, by entering the appropriate single dotted note and tying it to another note of the same pitch. For example, a double dotted C4 half note could be simulated by entering a dotted C4 half note tied to a C4 eighth note.

TRIPLETS

All of the durations, from whole note to thirty second note, are based on the number two. These durations allow notes to be played for one, two, or four beats, or for fractions of beats. This system works very well, except that it is difficult to handle durations based on the number three. To play a note for three beats, a dotted half note can be used. But how do you play a note for one third of a beat? Using dots will not help us here. Instead, we use a new kind of duration called a triplet.

A triplet consists of three notes that are played for the amount of time normally allotted to two notes. An eighth triplet is equal in duration to two eighth notes. Because two eighth notes form one beat, each of the three notes in a triplet is one third of a beat long.

(example)

A sixteenth triplet means that the amount of time used for two sixteenth notes, or one eighth note, is to be divided into three equal parts. Each of the three notes in the triplet plays for that duration. Triplets based on other durations, such as quarter notes, are also possible. Triplets are always written with a number 3 above or below them.

Pokey Player supports the eighth triplet, which is the one most frequently used. The Editor displays a triplet to the right of the whole note on the duration level. Even though a triplet is shown, the duration is actually one third of the triplet. To enter a complete triplet, you will have to enter three notes using this duration. This was done so that each of the three notes in a triplet can be a different pitch, or so that some of them might be a rest.

Not all tempo selections support the use of the eighth triplet. When you use the tempo command, a triplet symbol will be displayed after the word NO if the triplet is not available in the chosen tempo.

The Compiler indicates the use of a triplet note by printing a number 3 in the column where it normally prints the letters for other durations, such as W, H, and Q.

TIME SIGNATURES

The use of different time signatures is a more grandiose solution toward handling different kinds of durations. At the beginning of sheet music, right after the key signature, you will often find a fraction such as 4/4. The top number tells how many beats there are per measure, and the bottom number tells how many beats there are per whole note. Together, these two numbers define the "time signature." Up until now we have used only what is called "four four time," in which each measure contains four beats, and a whole note is four beats. When using different time signatures, there may be more or less than four beats in every measure, and a whole note may not always be four beats long.

One of the more common alternate time signatures is 3/4 time. This is just like 4/4 time, except that there are only three beats in every measure. Waltzes are often written in this time signature.

(example)

Another common time signature is 2/4 time. Once in a great while you may encounter an irregular time such as 7/4.

Changing the number of beats in a measure really does not affect Pokey Player. As long as you follow the sheet music, there should be not problem. The important thing is that each measure has the same number of beats. The Compiler prints the total number of frames for each measure, and will work correctly in any time signature.

Now let's talk about that bottom number. When it is 4, a whole note plays for four beats, so one fourth of that duration, a quarter note, plays for one beat. However, if the bottom number is 2, a whole note is only two beats long, and a quarter note is half a beat long. The half note plays for one beat. When the number on the bottom is 8, a quarter note plays for two beats, and the note for one beat is now an eighth note. The tempo stays the same; the number of beats per minute remains unchanged. It's the number of beats per note that is different.

Pokey Player is designed to always expect a whole note to be four beats, so that a quarter note is always one beat. There is no way to change the number of beats for these standard durations. However, time signatures which have a number other than 4 on the bottom can be used indirectly, by fooling the system into thinking that a whole note is longer or shorter than it actually is.

Consider the time signature 2/2, in which a whole note is two beats, compared to four beats in 2/4. A whole note is seemingly reduced to half of its normal duration. This can be achieved on Pokey Player by doubling the tempo. At faster tempo selections, more beats per minute means that each beat takes less time, so whole notes are shorter. Therefore, when the tempo is M.M. 100, 2/2 time can be simulated by actually using M.M. 200. (Since M.M. 200 is not available on Pokey Player, you would have to use M.M. 180 or 225.) To use a time signature such as 3/8, the tempo should be cut in half, making whole notes play twice as long as normal.

There is an alternate way to show a time signature without using numbers. Four four time can be indicated by a letter "C" that appears where the time signature belongs. The "C" stands for "common time." If the "C" has a vertical line passing through it, it indicates two two time.

One last word about time signatures is that they can change while a song is playing. Such changes are indicated by double bars followed by a new fraction or symbol.

TEMPO CHANGES

There are two kinds of tempo changes. In the first kind, the tempo will change abruptly, perhaps from a slow speed to a fast speed. This is most often found at the beginning of a movement or major part of a piece of music. In the second kind of tempo change, the tempo will increase or decrease gradually. This type of change is marked by the words "accelerando" and "ritardando," which repectively mean that the tempo should start getting faster or slower.

The only thing to be careful of when changing the tempo is to make sure that the voices stay synchronized. Therefore, tempo changes should only be done at a point in the music where all three voices are starting a new note. Usually, the beginning of a measure is a suitable place to change the tempo.

Listen to the piece called SCIPIO to hear a ritard. The ritard was done by using slower and slower tempo selections on the last few measures.

One other related symbol is the fermata, which looks like a narrow semicircle with a dot below it. A fermata can be placed over a particular note or rest to extend its duration. This is sometimes referred to as a "hold."

(example)

PARTIAL MEASURES

The only time when a measure may have less than the full number of beats is when it is the first or last measure. An example is when the first note in a song starts on a fourth beat. Rather than drawing the preceding rests, a partial measure is used.

DYNAMICS

Volume changes are the most common type of change in music. As with the tempo, the dynamics can change immediately or gradually. Immediate changes are indicated in the normal way, using letter combinations such as "p" and "fff". Gradual changes are marked by the words "crescendo" and "decrescendo," which respectively mean that the volume should gradually increase or decrease. Use the command which sets the noise and volume to increase or decrease the volume by one level every couple of measures.

An accent mark looks like a "greater than" sign. When placed above a note, it means that the note should be played just a little louder than the other notes. To simulate an accent, set the volume about two levels higher, play the note, and then set the volume back before the next note.

REVISED POKEY PLAYER DOCUMENTATION PART NINE
by Craig Chamberlain 1/24/84

THE DYNABYTE PROGRAM

When a note is played, it increases in volume according to the attack rate, reaches a sustain level, and stays there until it releases, when it fades away in volume. The changes in volume help distinguish notes of the same pitch from each other. If there was no release, the volume would always stay at the sustain level, and the music would have a smooth, flowing feel. This effect is called "legato." On the other hand, if the volume began to release soon after the attack, the notes would sound very short and choppy. This style is called "staccato." Staccato notes are designated by placing a dot above or below them. One feature missing from the Editor is that although notes can be played legato by using ties, there is no easy way to achieve the staccato effect.

Another missing feature is that there are not a whole lot of tempo selections available. Of those that are available, some do not support thirty second notes or triplets.

The Editor and Compiler provide no means of getting around these problems. However, the Dynabyte program can be used to change a voice after it has been compiled, opening up a few new possibilities.

Take a look at a compilation report for a voice which uses the command that sets noise and volume parameters. The first line is identified as PPPARM, and the compiled byte is always an 8. The next byte contains the noise and volume information. The third byte tells the release point. This number is always one greater than the volume level. If the volume is being set to 5, the number for the release point will be 6. This means that the release will begin six frames from the end of every note. A quarter note in M.M. 100 has a duration of 36 frames, so the note will be at the specified volume for the first 30 frames, and then start to fade, one volume level per frame.

By adjusting the release point, you can get different types of effects. For example, using the number 0 means that the notes will never release, and the voice will be completely legato. Using a value of 255 means that each note will start to release as soon as it is played, thus producing a staccato effect. Values between 0 and 255 produce effects that are between these two extremes.

To change the release point, run the Dynabyte program. Answer the device specification prompt by typing "D:" and the filename of the compiled voice to be changed. This must be a .V1, .V2, or .V3 file. Dynabyte must be used to change a compiled voice before it is merged with others.

After the file is loaded, you will see a question mark. The program wants to know which byte is to be changed. The compilation report gives the number for each byte in the file in the first column. When you enter the byte number, Dynabyte will tell you what the current value is, and ask you what the new value should be. If you do not want to change the value, just press RETURN. Otherwise, enter the new value.

Dynabyte will return to the question mark, waiting for another byte number. You can go and change other bytes if you want. If you are done, just press RETURN. Dynabyte will ask for a device specification. Type the same filename as before. The updated file will then be saved. You are now set to merge the voices using Vmerge. Of course, every time that you recompile the voice, you will have to use Dynabyte again.

Dynabyte can also be used to change the tempo command, which is labeled as PPTEMP in the compilation report. The first byte will always be a 32. The next seven bytes are the frame counts for the various durations. The durations start with the thirty second note and continue up to the whole note. The last byte is the frame count for the eighth triplet. If you want to change the triplet into a different duration, perhaps a sixteenth triplet, calculate the correct frame count and change the last byte of the tempo command. Another possible duration is a sixty fourth note.

The reason that some tempo selections are not available is because the frame counts cannot be divided down far enough. In M.M. 120, which is not normally available, an eighth note is 15 frames. It is not possible to evenly divide the number 15 by two for a sixteenth note. However, if a piece of music does not contain any sixteenth notes, this tempo can be used. You will have to change every byte in the tempo command, following the tempo sheet. Use a zero for those durations which are not available.

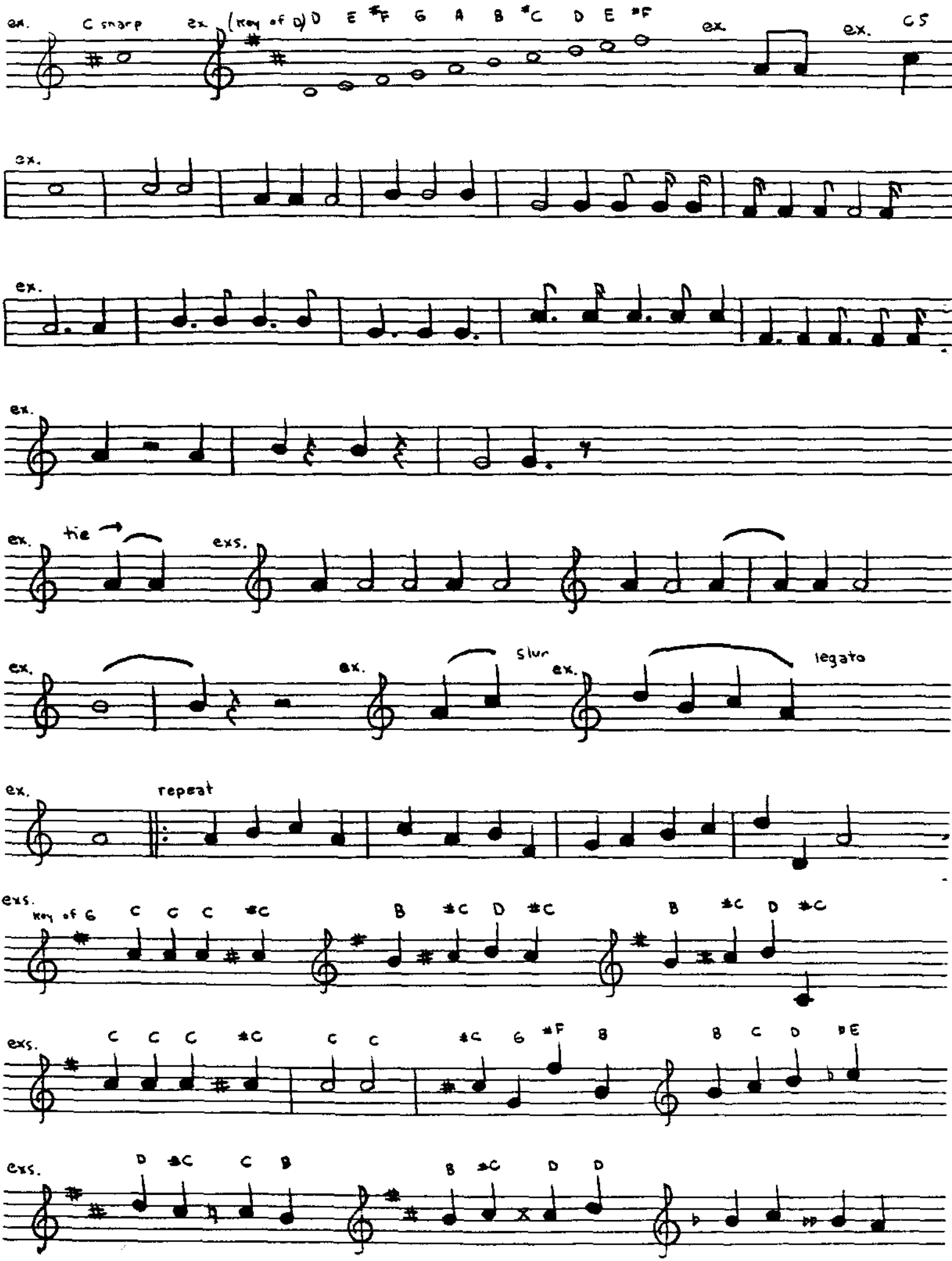
Although it is not possible to play a sixteenth note in M.M. 120, it is possible to play a pair of sixteenth notes. Keep in mind the fact that an eighth note plays for 15 frames. Instead of setting the duration for a sixteenth note to zero, set it to 7. Then set the duration for the triplet to 8. Now you can play two sixteenth notes by actually playing a sixteenth note and a triplet note. The total duration will be correct. This trick can also be used in the normally available tempo selections to get pairs of thirty second notes.

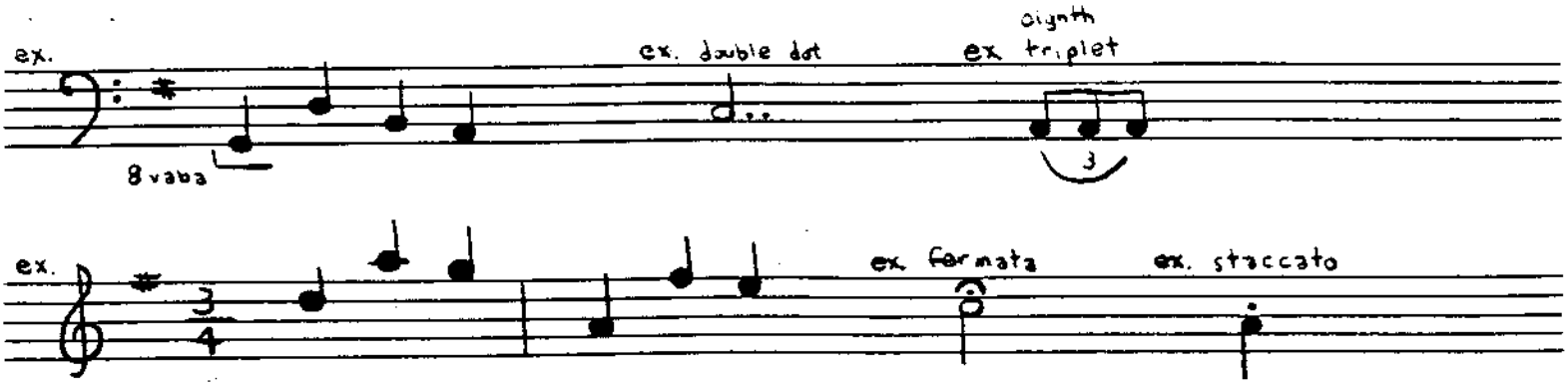
This concludes the documentation for the Revised Pokey Player. The Editor was written by Harry Bratt, and the Compiler and Player were written by Craig Chamberlain.

Pokey Player was written to put the POKEY chip through its paces. The authors have given you a very capable music tool to do just that. Now it is your turn to put Pokey Player through its paces. We look forward to hearing the results.

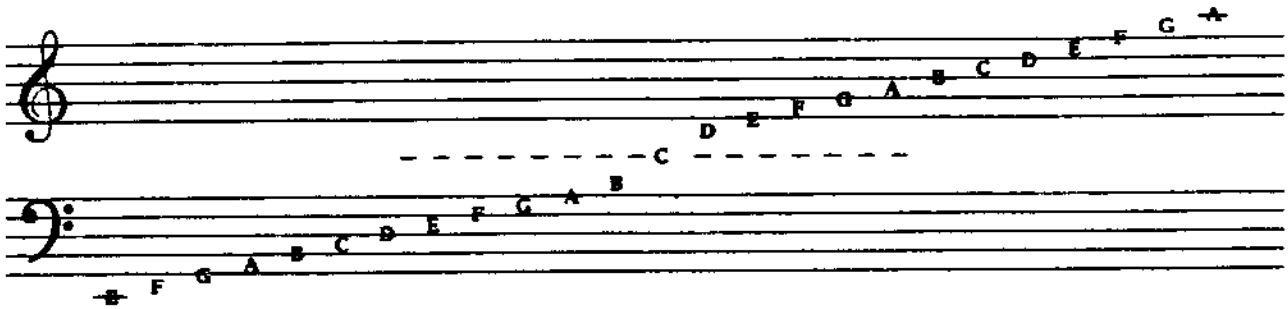
Song contributions are greatly appreciated. Please mail them to:

Craig Chamberlain
17094 Dunblaine
Birmingham, MI 48009

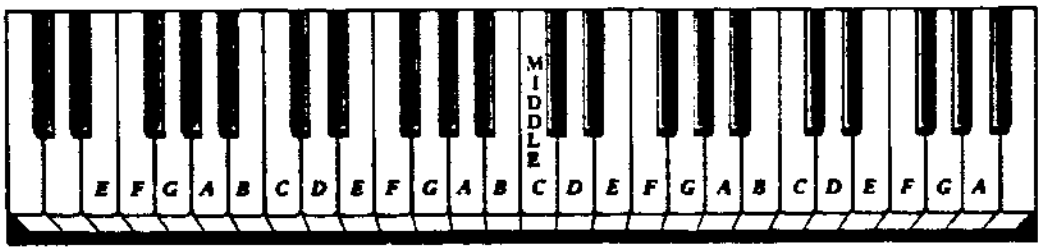

ex.
C sharp
ex.
(key of D) D E #F G A B #C D E #F
ex.
ex. G5
ex.
ex.
ex.
tie
exs.
ex.
ex.
slur
ex.
legato
ex.
repeat
exs.
key of G
C C C #C
B #C D #C
B #C D #C
exs.
C C C #C
C C
#C G #F B
B C D #E
exs.
D #C C B
B #C D D



GRAND STAFF This is the grand staff showing how the treble and bass staves are combined to give us the tools for representing most of the tones we hear. Notice that the leger lines are but a continuation of the grand staff.



In the chart below we see a diagram of the piano keyboard and the notes for the "white keys" as shown on the grand staff.



4 beats	*Whole note*		*Whole rest*
2 beats	*Half note*		*Half rest*
1 beat	*Quarter note*		*Quarter rest*
1/2 beat	*Eighth note*		*Eighth rest*
1/4 beat	*Sixteenth note*		*Sixteenth rest*
1/8 beat	*Thirty-second note*		*Thirty-second rest* 

```
POKEY PLAYER COMPILATION REPORT

00001 00000 032 20  PPTEMP (180)
00002 00000 000 00
00003 00000 005 05
00004 00000 010 0A
00005 00000 020 14
00006 00000 040 28
00007 00000 080 50
00008 00000 000 00
00009 00000 008 08  PPPARM (10,6)
00010 00000 166 A6
00011 00000 007 07

MEASURE NUMBER 1
00012 00000 128 80 -1
00013 00020 044 2C  2 G  Q
00014 00020 132 84 +1
00015 00040 068 44  3 G  Q
00016 00060 044 2C  3 D  Q
00017 00080 084 54  3 E  Q
** DURATION ** 80 FRAMES

MEASURE NUMBER 2
00018 00100 092 5C  3 G  Q
00019 00120 068 44  3 G  Q
00020 00140 068 44  3 G  Q
00021 00160 012 0C  3 F+ Q
** DURATION ** 80 FRAMES

MEASURE NUMBER 3
00022 00180 004 04     R  Q
00023 00200 020 14  3 E  Q
00024 00220 044 2C  2 B  Q
00025 00240 092 5C  3 D  Q
** DURATION ** 80 FRAMES

MEASURE NUMBER 4
00026 00260 084 54  3 E  Q
00027 00280 068 44  3 E  Q
00028 00300 068 44  3 E  Q
00029 00320 020 14  3 D  Q
** DURATION ** 80 FRAMES

MEASURE NUMBER 5
00030 00340 020 14  3 C  Q
00031 00360 068 44  3 C  Q
00032 00380 044 2C  2 G  Q
00033 00400 084 54  2 A  Q
** DURATION ** 80 FRAMES

MEASURE NUMBER 6
00034 00410 091 5B  3 C  E
00035 00420 067 43  3 C  E
00036 00430 067 43  3 C  E
00037 00440 075 4B  3 C+ E
** DURATION ** 40 FRAMES

MEASURE NUMBER 7
00038 00460 076 4C  3 D  Q
00039 00480 068 44  3 D  Q
00040 00500 044 2C  2 A  Q
00041 00520 084 54  2 B  Q
** DURATION ** 80 FRAMES

MEASURE NUMBER 8
00042 00540 220 DC  3 D  Q   T
00043 00560 148 94  3 C  Q   T
00044 00580 140 8C  2 B  Q   T
00045 00600 148 94  2 A  Q   T
** DURATION ** 80 FRAMES

MEASURE NUMBER 9
00046 00680 022 16  2 G  W
00047 00680 120 78  PPSTOP
00048 00700 004 04     R  Q

TOTALS: 48 BYTES, 700 FRAMES
```

TEMPO VALUES FOR 60 Hz PLAYER

M.M.	W	H	Q	E	S	32	64	E/3
900	16	8	4	2	1	0.5	0.25	
600	24	12	6	3	1.5	0.75	0.375	2
450	32	16	8	4	2	1	0.5	
360	40	20	10	5	2.5	1.25	0.625	
300	48	24	12	6	3	1.5	0.75	4
257	56	28	14	7	3.5	1.75	0.875	
225	64	32	16	8	4	2	1	
200	72	36	18	9	4.5	2.25	1.125	6
180	80	40	20	10	5	2.5	1.25	
163	88	44	22	11	5.5	2.75	1.375	
150	96	48	24	12	6	3	1.5	8
138	104	52	26	13	6.5	3.25	1.625	
128	112	56	28	14	7	3.5	1.75	
120	120	60	30	15	7.5	3.75	1.875	10
112	128	64	32	16	8	4	2	
105	136	68	34	17	8.5	4.25	2.125	
100	144	72	36	18	9	4.5	2.25	12
94	152	76	38	19	9.5	4.75	2.375	
90	160	80	40	20	10	5	2.5	
85	168	84	42	21	10.5	5.25	2.625	14
81	176	88	44	22	11	5.5	2.75	
78	184	92	46	23	11.5	5.75	2.875	
75	192	96	48	24	12	6	3	16
72	200	100	50	25	12.5	6.25	3.125	
69	208	104	52	26	13	6.5	3.25	
66	216	108	54	27	13.5	6.75	3.375	18
64	224	112	56	28	14	7	3.5	
62	232	116	58	29	14.5	7.25	3.625	
60	240	120	60	30	15	7.5	3.75	20
58	248	124	62	31	15.5	7.75	3.875	
56	256	128	64	32	16	8	4	