

# Appendix A: Programming Language Grammar

## Regular Expressions:

<i>&lt;identifier&gt;</i>	::= [a-zA-Z][a-zA-Z0-9_]*
<i>&lt;string&gt;</i>	::= ".*"
<i>&lt;integer&gt;</i>	::= [0-9]+
<i>&lt;single&gt;</i>	::= [0-9]*"."[0-9]*([Ee][+-]?[0-9]+)?s?
<i>&lt;double&gt;</i>	::= [0-9]*"."[0-9]*([Ee][+-]?[0-9]+)?d?
<i>&lt;fixed&gt;</i>	::= [0-9]*"."[0-9]*([Ee][+-]?[0-9]+)?f?

## LL(1) Grammar:

<i>&lt;form&gt;</i>	::= <i>&lt;function&gt;</i> ; ::= <i>&lt;prototype&gt;</i> ;
<i>&lt;function&gt;</i>	::= <b>func</b> <i>&lt;identifier&gt;</i> ( <i>&lt;formalparamstart&gt;</i> ) : <i>&lt;type&gt;</i> <i>&lt;expr&gt;</i>
<i>&lt;prototype&gt;</i>	::= <b>proto</b> <i>&lt;identifier&gt;</i> ( <i>&lt;formalparamstart&gt;</i> ) : <i>&lt;type&gt;</i>
<i>&lt;formalparamstart&gt;</i>	::= <i>&lt;formalparamlist&gt;</i> ::=
<i>&lt;type&gt;</i>	::= <b>bool</b> ::= <b>int</b> ::= <b>single</b> ::= <b>double</b> ::= <b>fixed</b> ::= <b>boolarray</b> ::= <b>intarray</b> ::= <b>singlearray</b> ::= <b>doublearray</b> ::= <b>fixedarray</b>
<i>&lt;expr&gt;</i>	::= <i>&lt;expr2&gt;</i> ::= <b>if</b> <i>&lt;ifrest&gt;</i> ::= <i>&lt;whileloop&gt;</i> ::= <b>do</b> <i>&lt;expr&gt;</i> <i>&lt;loopwhileuntil&gt;</i> ::= <i>&lt;untilloop&gt;</i> ::= <b>set</b> <i>&lt;expr&gt;</i> := <i>&lt;expr&gt;</i> ::= <b>resize</b> <i>&lt;expr&gt;</i> <b>to</b> <i>&lt;expr&gt;</i> ::= <b>error</b> <i>&lt;string&gt;</i> <b>resumable</b> <i>&lt;expr&gt;</i> ::= <b>getsampleleft</b> <i>&lt;string&gt;</i> ::= <b>getsampleright</b> <i>&lt;string&gt;</i> ::= <b>getsample</b> <i>&lt;string&gt;</i> ::= <b>getwavenumframes</b> <i>&lt;string&gt;</i> ::= <b>getwavenumtables</b> <i>&lt;string&gt;</i> ::= <b>getwavedata</b> <i>&lt;string&gt;</i> ::= <b>print</b> <i>&lt;string&gt;</i> ::= <b>print</b> <i>&lt;expr&gt;</i>
<i>&lt;formalparamlist&gt;</i>	::= <i>&lt;formalarg&gt;</i> <i>&lt;formalargtail&gt;</i>
<i>&lt;whileloop&gt;</i>	::= <b>while</b> <i>&lt;expr&gt;</i> <b>do</b> <i>&lt;expr&gt;</i>

<untilloop>	::= <b>until</b> <expr> <b>do</b> <expr>
<vartail>	::= = <expr> ::= ( <expr> )
<ifrest>	::= <expr> <b>then</b> <expr> <iftail>
<loopwhileuntil>	::= <b>while</b> <expr> ::= <b>until</b> <expr>
<expr2>	::= <expr3> <expr2prime>
<formalarg>	::= <identifier> : <type>
<formalargtail>	::= , <formalparamlist> ::=
<iftail>	::= <b>else</b> <expr> ::= <b>elseif</b> <ifrest> ::=
<expr3>	::= <expr4> <expr3prime>
<expr2prime>	::= <conj_oper> <expr3> <expr2prime> ::=
<expr4>	::= <expr5> <expr4prime>
<expr3prime>	::= <rel_oper> <expr4> <expr3prime> ::=
<conj_oper>	::= <b>and</b> ::= <b>or</b> ::= <b>xor</b>
<expr5>	::= <expr6> <expr5prime>
<expr4prime>	::= <add_oper> <expr5> <expr4prime> ::=
<rel_oper>	::= < ::= <= ::= > ::= >= ::= = ::= <>
<expr6>	::= <unary_oper> <expr6> ::= <expr7>
<unary_oper>	::= <b>not</b> ::= <b>sin</b> ::= <b>cos</b> ::= <b>tan</b> ::= <b>asin</b> ::= <b>acos</b> ::= <b>atan</b> ::= <b>ln</b> ::= <b>exp</b>

```

::= bool
::= int
::= single
::= double
::= fixed
::= sqr
::= sqrt
::= abs
::= -
::= sign
::= length

<expr5prime> ::= <mult_oper> <expr6> <expr5prime>
::=

<add_oper> ::= +
::= -

<expr7> ::= <expr8> <expr7prime>

<mult_oper> ::= *
::= /
::= div
::= mod
::= <<
::= >>

<expr8> ::= <identifier>
::= <integer>
::= <single>
::= <double>
::= <fixed>
::= <string>
::= true
::= false
::= ( <exprlist> )

<expr7prime> ::= <arraysubscript>
::= <funccall>
::= <exponentiation>
::=

<funccall> ::= ( <actualstart> )

<arraysubscript> ::= [ <exprlist> ]

<exprlist> ::= <exprlistelem> <exprlisttail>

<exponentiation> ::= ^ <expr7>

<actualstart> ::= <actuallist>
::=

<actuallist> ::= <expr> <actualtail>

<actualtail> ::= , <actuallist>
::=

<exprlisttail> ::= ; <exprlist>

```

*<exprlistelem>* ::= *<expr>*  
 ::= **var** *<identifier>* : *<type>* *<vartail>*  
 ::= *<prototype>*

## Appendix B: Instrument Definition Grammar

Terminals:

```

<identifier> ::= ([a-zA-Z][a-zA-Z0-9_]*) | (".*")
<integer> ::= [0-9]+
<float> ::= [0-9]*"."?[0-9]*([Ee][+-]?[0-9]+)?
<boolean> ::= true | false

```

LL(1) Grammar:

```

<instr_definition> ::= instrument ( <instr_list> )

<instr_list> ::= <instr_elem> ; <instr_list>
               ::=

<instr_elem> ::= loudness <number>
                ::= frequencylfo ( <lfo_definition> )
                ::= oscillator <identifier> ( <oscillator_definition> )
                ::= trackeffect <trackeffects>

<number> ::= <integer>
           ::= <float>

<lfo_definition> ::= <lfo_elem> ; <lfo_definition>
                  ::=

<oscillator_definition> ::= <oscillator_elem> ; <oscillator_definition>
                          ::=

<lfo_elem> ::= freqenvelope ( <envelope_definition> )
              ::= ampenvelope ( <envelope_definition> )
              ::= oscillator <oscillator_type>
              ::= modulation <modulation_type>
              ::= exponential
              ::= linear

<oscillator_type> ::= constant
                   ::= signsine
                   ::= plussine
                   ::= signtriangle
                   ::= plustriangle
                   ::= signsquare <number>
                   ::= plussquare <number>
                   ::= signramp <number>
                   ::= plusramp <number>
                   ::= signlinfuzz <number> <interspec>
                   ::= pluslinfuzz <number> <interspec>
                   ::= wavetable samplelist ( <samplelist_definition> ) envelope (
                   <envelope_definition> )

<interspec> ::= square
              ::= triangle

<modulation_type> ::= additive

```

```

::= multiplicative
::= inversemult

<oscillator_elem> ::= type <oscillator_type>
::= samplelist ( <samplelist_definition> )
::= loudness <number>
::= freqmultiplier <number>
::= freqdivisor <integer>
::= freqadder <number>
::= makeoutput <boolean>
::= loudnessenvelope ( <envelope_definition> )
::= loudnesslfo ( <lfo_definition> )
::= indexenvelope ( <envelope_definition> )
::= indexlfo ( <lfo_definition> )
::= stereobias <number>
::= displacement <number>
::= frequencylfo ( <lfo_definition> )

<oscillator_type> ::= sampled
::= wavetable

<envelope_definition> ::= <envelope_elem> ; <envelope_definition>
::=

<samplelist_definition> ::= <samplelist_elem> ; <samplelist_definition>
::=

<envelope_elem> ::= totalscaling <number>
::= points ( <env_point_list> )

<samplelist_elem> ::= <identifier> <number>

<env_point_list> ::= <env_point_elem> ; <env_point_list>
::=

<env_point_elem> ::= delay <number> level <number> <env_attributes>
::= delay <number> scale <number> <env_attributes>
::= origin

<env_attributes> ::= <env_one_attribute> <env_attributes>
::=

<env_one_attribute> ::= sustainpoint <integer>
::= releasepoint <integer>
::= sustainpointnoskip <integer>
::= releasepointnoskip <integer>
::= ampaccent1 <number>
::= ampaccent2 <number>
::= ampaccent3 <number>
::= ampaccent4 <number>
::= ampfreq slope <number> center <number>
::= rateaccent1 <number>
::= rateaccent2 <number>
::= rateaccent3 <number>
::= rateaccent4 <number>
::= ratefreq slope <number> center <number>
::= exponential
::= linear

```

<code>&lt;trackeffects&gt;</code>	<pre> <b>::= delayline ( &lt;delayelems&gt; )</b> <b>::= nlproc wavetable &lt;identifier&gt; inputscaling &lt;number&gt; outputscaling</b> <b>&lt;number&gt; index &lt;number&gt; &lt;nlattributes&gt;</b> <b>::= filter ( &lt;filterelems&gt; )</b> <b>::= analyzer &lt;string&gt;</b> </pre>
<code>&lt;delayelems&gt;</code>	<pre> <b>::= maxdelaytime &lt;number&gt;</b> <b>::= tap &lt;tapchannel&gt; &lt;number&gt; to &lt;tapchannel&gt; &lt;number&gt; scale &lt;number&gt;</b> <b>&lt;tapattributes&gt;</b> </pre>
<code>&lt;tapchannel&gt;</code>	<pre> <b>::= left</b> <b>::= right</b> <b>::= mono</b> </pre>
<code>&lt;tapattributes&gt;</code>	<pre> <b>::= &lt;tapattr&gt; &lt;tapattributes&gt;</b> <b>::=</b> </pre>
<code>&lt;tapattr&gt;</code>	<pre> <b>::= sourceaccent1 &lt;number&gt;</b> <b>::= sourceaccent2 &lt;number&gt;</b> <b>::= sourceaccent3 &lt;number&gt;</b> <b>::= sourceaccent4 &lt;number&gt;</b> <b>::= targetaccent1 &lt;number&gt;</b> <b>::= targetaccent2 &lt;number&gt;</b> <b>::= targetaccent3 &lt;number&gt;</b> <b>::= targetaccent4 &lt;number&gt;</b> <b>::= scaleaccent1 &lt;number&gt;</b> <b>::= scaleaccent2 &lt;number&gt;</b> <b>::= scaleaccent3 &lt;number&gt;</b> <b>::= scaleaccent4 &lt;number&gt;</b> <b>::= movingaveragelowpass</b> </pre>
<code>&lt;nlattributes&gt;</code>	<pre> <b>::= inputaccent1 &lt;number&gt;</b> <b>::= inputaccent2 &lt;number&gt;</b> <b>::= inputaccent3 &lt;number&gt;</b> <b>::= inputaccent4 &lt;number&gt;</b> <b>::= outputaccent1 &lt;number&gt;</b> <b>::= outputaccent2 &lt;number&gt;</b> <b>::= outputaccent3 &lt;number&gt;</b> <b>::= outputaccent4 &lt;number&gt;</b> <b>::= indexaccent1 &lt;number&gt;</b> <b>::= indexaccent2 &lt;number&gt;</b> <b>::= indexaccent3 &lt;number&gt;</b> <b>::= indexaccent4 &lt;number&gt;</b> </pre>
<code>&lt;filterelems&gt;</code>	<pre> <b>::= &lt;filterelem&gt; ; &lt;filterelems&gt;</b> <b>::=</b> </pre>
<code>&lt;filterelem&gt;</code>	<pre> <b>::= filter &lt;filtertype&gt; freq &lt;number&gt; &lt;bandwidth&gt; &lt;scaling&gt; &lt;tapchannel&gt;</b> <b>&lt;filterattributes&gt;</b> </pre>
<code>&lt;filtertype&gt;</code>	<pre> <b>::= lowpass</b> <b>::= highpass</b> <b>::= reson</b> <b>::= zero</b> <b>::= butterworthlowpass</b> <b>::= butterworthhighpass</b> <b>::= butterworthbandpass</b> <b>::= butterworthbandreject</b> </pre>

*<bandwidth>* ::= **bandwidth** *<number>*  
::=

*<scaling>* ::= **defaultscaling**  
::= **unitymidbandgain**  
::= **unitynoise gain**  
::= **unityzero hertz gain**

*<filterattributes>* ::= *<filterattr>* *<filterattributes>*  
::=

*<filterattr>* ::= **freqaccent1** *<number>*  
::= **freqaccent2** *<number>*  
::= **freqaccent3** *<number>*  
::= **freqaccent4** *<number>*  
::= **bandwidthaccent1** *<number>*  
::= **bandwidthaccent2** *<number>*  
::= **bandwidthaccent3** *<number>*  
::= **bandwidthaccent4** *<number>*  
::= **outputscaling** *<number>*  
::= **outputaccent1** *<number>*  
::= **outputaccent2** *<number>*  
::= **outputaccent3** *<number>*  
::= **outputaccent4** *<number>*

## Appendix C: Grammar for File Format

This section describes version 2 of the file format used by *Out Of Phase*. The version 1 file format is now obsolete. The latest version of *Out Of Phase* should be used to convert old files into the newest file format.

The file format is hierarchical, and points where a sub-block is inserted are denoted in italics.

### General Information Subblock Structure:

- 4-byte file format version code
- "Syn2"
- 1-byte unsigned tab size code  
should be in the range of 1..255
- 4-byte little endian comment text length (positive 2s complement, in bytes)
- n-byte character data for comment text (line feed = 0x0a)
- 1-byte stereo playback flag
  - 0 = mono
  - 1 = stereo
- 1-byte surround encoding flag
  - 0 = no surround encoding
- 4-byte little endian output sampling rate  
should be in the range of 100..65535
- 4-byte little endian envelope update rate  
should be in the range of 1..65535
- 4-byte little endian large integer coded decimal beats per minute  
large integer coded decimal is decimal \* 1000000 with a  
range of -1999.999999 to 1999.999999
- 4-byte little endian large integer coded decimal total volume scaling factor
- 1-byte number of bits to output  
should be 8, 16, 24, or 32
- 1-byte flag for interpolation over time
  - 0 = don't interpolate over time
  - 1 = do interpolate over time (when resampling waveforms)
- 1-byte flag for interpolation across waves
  - 0 = don't interpolate across waves
  - 1 = do interpolate across waves (when wave table synthesis index is  
not an integer)
- 4-byte little endian large integer coded decimal scanning gap (in seconds)
- 4-byte little endian large integer coded decimal buffer duration (in seconds)
- 1-byte flag for clipping warning
  - 0 = don't warn about clipped samples
  - 1 = do warn about clipped samples
- 1-byte flag for song post processing enabling
  - 0 = don't do song postprocessing
  - 1 = do song postprocessing
- 4-byte little endian length of song post processing function
- n-bytes of post processing function text (line feed = 0x0a)
  
- 4-byte little endian number of tracks (positive 2s complement)  
*n-bytes data for the track objects (see below)*  
*n-bytes data for background display information (a chunk for each track, see below)*
  
- 4-byte little endian function object count (positive 2s complement)  
*n-bytes of data for the function objects (see below)*
  
- 4-byte little endian number of algorithmic sample objects (positive 2s complement)  
*n-byte data for the algorithmic sample objects (see below)*

4-byte little endian number of algorithmic wave table objects (positive 2s complement)  
*n-byte data for all the algorithmic wave table objects (see below)*

4-byte little endian number of instrument objects (positive 2s complement)  
*n-byte data for the instrument objects (see below)*

4-byte little endian number of wave table objects (positive 2's complement)  
*n-bytes data for the wave table objects (see below)*

4-bytes little endian number of sample objects (positive 2s complement)  
*n-bytes of data for the sample objects (see below)*

### **Sample Object Subblock Structure:**

1-byte sample version number  
 should be 1

2-byte little endian window X position (signed, origin at top-left corner)

2-byte little endian window Y position

2-byte little endian window width

2-byte little endian window height

4-byte little endian sample name length descriptor (positive 2's complement)

*n-byte sample name text (line feed = 0x0a)*

4-byte little endian sample formula length descriptor (positive 2's complement)

*n-byte sample formula text (line feed = 0x0a)*

4-byte little endian sample frame index of sample's origin

4-byte little endian sample frame index of loop 1 start  
 must be a valid index, i.e.  $\geq 0$  and  $<$  num sample frames

4-byte little endian sample frame index of loop 1 end  
 must be a valid index, i.e.  $\geq 0$  and  $<$  num sample frames  
 also, loop end must not be less than loop start

4-byte little endian sample frame index of loop 2 start  
 must be a valid index, i.e.  $\geq 0$  and  $<$  num sample frames

4-byte little endian sample frame index of loop 2 end  
 must be a valid index, i.e.  $\geq 0$  and  $<$  num sample frames  
 also, loop end must not be less than loop start

4-byte little endian sample frame index of loop 3 start  
 must be a valid index, i.e.  $\geq 0$  and  $<$  num sample frames

4-byte little endian sample frame index of loop 3 end  
 must be a valid index, i.e.  $\geq 0$  and  $<$  num sample frames  
 also, loop end must not be less than loop start

4-byte little endian sampling rate value  
 should be between 100 and 65535

4-byte little endian natural frequency fractional portion  
 unsigned; divide by  $2^{32}$  to get the actual fraction

4-byte little endian natural frequency integer portion  
 total natural frequency should be between 0.01 and  $1e6$

4-byte total number of sample frames

1-byte mono/stereo flag

1 = mono

2 = stereo

1-byte number of bits per sample point  
 should be 8 or 16

*n-bytes of data for sample frames*

*stereo samples have the left channel sample point preceding the right channel sample point.*

*sample points that require more than 1 byte are stored little endian*

*all sample data is stored in signed 2's complement form*

**Function Object Subblock Structure:**

- 1-byte function object version number  
should be 1
- 2-byte little endian window x location (origin at top-left of screen)
- 2-byte little endian window y location
- 2-byte little endian window width
- 2-byte little endian window height
- 4-byte little endian object name length (positive 2s complement)
- n-byte name data (line feed = 0x0a)
- 4-byte little endian function source text length (positive 2s complement)
- n-byte function source text data (line feed = 0x0a)

**Algorithmic Sample Object Subblock Format:**

- 1-byte format version number  
should be 1
- 2-bytes little endian window X location (signed, origin at top-left corner)
- 2-bytes little endian window Y location
- 2-bytes little endian window width
- 2-bytes little endian window height
- 4-bytes little endian name length descriptor
- n-bytes name string (line feed = 0x0a)
- 4-bytes little endian formula length descriptor
- n-bytes formula string (line feed = 0x0a)
- 1-byte number of bits  
should be 8 or 16
- 1-byte number of channels
  - 1 = mono
  - 2 = stereo
- 4-bytes little endian sample origin
- 4-bytes little endian loop 1 start point
- 4-bytes little endian loop 1 end point
- 4-bytes little endian loop 2 start point
- 4-bytes little endian loop 2 end point
- 4-bytes little endian loop 3 start point
- 4-bytes little endian loop 3 end point
- 4-bytes little endian sampling rate  
should be between 100 and 65535
- 4-byte little endian natural frequency fractional portion  
unsigned; divide by  $2^{32}$  to get the actual fraction
- 4-byte little endian natural frequency integer portion  
total natural frequency should be between 0.01 and 1e6

**Wave Table Object Subblock Format:**

- 1-byte format version number  
should be 1
- 2-byte little endian window X location (signed; origin at upper left corner)
- 2-byte little endian window Y location
- 2-byte little endian window width
- 2-byte little endian window height
- 4-byte little endian wave table name length descriptor
- n-byte name string (line feed = 0x0a)
- 4-byte little endian wave table formula length descriptor
- n-byte formula string (line feed = 0x0a)
- 4-byte little endian large integer encoded test attack duration.  
large integer coded decimal is decimal \* 1000000 with a range of -1999.999999 to 1999.999999
- 4-byte little endian large integer encoded test decay duration.
- 4-byte little endian test frequency fractional portion  
unsigned; divide by  $2^{32}$  to get the actual fraction

4-byte little endian test frequency integer portion  
 total test frequency should be between 0.01 and 1e6

4-byte little endian test sampling rate  
 should be between 100 and 65535

4-byte little endian number of tables

4-byte little endian number of frames per table  
 must be an integral power of 2 between 2 and 65536

1-byte number of bits specifier  
 must be 8 or 16

n-byte sample data for the wave table  
 data is stored as follows: each table is stored consecutively starting with the table numbered 0. in each table, each sample frame is stored consecutively as a signed 2s complement value. 8-bit sample frames use 1 byte each. 16-bit sample frames use 2 bytes and are stored little endian.

#### **Algorithmic Wave Table Object Subblock Format:**

1-byte format version number  
 should be 1

2-byte little endian window X position (signed; origin at top-left corner)

2-byte little endian window Y position

2-byte little endian window width

2-byte little endian window height

4-byte little endian name length descriptor

n-byte name string (line feed = 0x0a)

4-byte little endian formula length descriptor

n-byte formula string (line feed = 0x0a)

4-byte little endian number of frames  
 should be an integral power of 2 in the interval 2..65536

4-byte little endian number of tables

1-byte number of bits  
 should be either 8 or 16

#### **Instrument Object Subblock Format:**

1-byte format version number  
 should be 1

2-byte little endian window X location (signed; origin at top-left of screen)

2-byte little endian window Y location

2-byte little endian window width

2-byte little endian window height

4-byte little endian name string length

n-byte name string (line feed = 0x0a)

4-byte little endian instrument definition length

n-byte instrument definition string (line feed = 0x0a)

#### **Track Object Subblock Format:**

1-byte format version number  
 should be 2

2-byte little endian window X position (signed; from top-left corner of screen)

2-byte little endian window Y position

2-byte little endian window width

2-byte little endian window height

4-byte little endian track name length descriptor

n-byte track name string (line feed = 0x0a)

4-byte little endian large integer coded decimal default early/late adjust  
 large integer coded decimal is decimal \* 1000000 with a range of -1999.999999 to 1999.999999

4-byte little endian large integer coded decimal default release point 1

1-byte default release point 1 mode flag

0 = release from start  
 1 = release from end  
 4-byte little endian large integer coded decimal default release point 2  
 1-byte default release point 2 mode flag  
   0 = release from start  
   1 = release from end  
 4-byte little endian large integer coded decimal default overall loudness  
 4-byte little endian large integer coded decimal default stereo positioning  
 4-byte little endian large integer coded decimal default surround positioning  
 4-byte little endian large integer coded decimal default accent 1  
 4-byte little endian large integer coded decimal default accent 2  
 4-byte little endian large integer coded decimal default accent 3  
 4-byte little endian large integer coded decimal default accent 4  
 4-byte little endian large integer coded decimal default pitch disp depth adjust  
 4-byte little endian large integer coded decimal default pitch disp rate adjust  
 4-byte little endian large integer coded decimal default pitch disp start point  
 1-byte default pitch displacement start point mode flag  
   0 = pitch displacement point from start  
   1 = pitch displacement point from end  
 4-byte little endian large integer coded decimal default hurry-up factor  
 4-byte little endian large integer coded decimal default detuning  
 1-byte default detuning mode flag  
   0 = half steps  
   1 = hertz  
 4-byte little endian large integer coded decimal default duration  
 1-byte default duration mode flag  
   0 = duration adjust is multiplicative  
   1 = duration adjust is additive  
 1-byte flag for playback inclusion  
   0 = don't play track in final playback  
   1 = do play track in final playback  
 4-byte little endian instrument name string length descriptor  
 n-byte instrument name string (line feed = 0x0a)  
 1-byte flag for channel post processing enabling  
   0 = don't do channel postprocessing  
   1 = do channel postprocessing  
 4-byte little endian postprocessing expression length descriptor  
 n-bytes of postprocessing stuff (line feed = 0x0a)  
*n-bytes of data for note vector*

**Note Vector Subblock Format:**

1-byte format version number  
   should be 2  
 4-byte little endian number of frames in the vector  
 \* for each frame:  
   4-byte little endian number of notes in the frame  
   *n-bytes of data for all of the notes (see note object format)*  
 4-byte little endian number of records in the tie matrix  
 \* for each tie matrix entry:  
   4-byte little endian index of the source frame  
   4-byte little endian index of the source note in the frame  
   4-byte little endian index of the target frame  
   4-byte little endian index of the target note in the frame

**Note Object Subblock Format:**

Each note/command has the following field:

4-byte unsigned little endian opcode field  
   for a command, the high bit will be 1 and the remaining bits will  
   be the opcode. for a note, the high bit will be 0.

## Remainder of Note Variant Subblock:

definitions for the remaining bits in the opcode field

bits 0-3: duration integer.

0001 = 64th note

0010 = 32nd note

0011 = 16th note

0100 = 8th note

0101 = quarter note

0110 = half note

0111 = whole note

1000 = double note

1001 = quad note

all other values are not permitted

bits 4-5: division mask

00 = divide duration by 1 (no change in duration)

01 = divide duration by 3 (triplets)

10 = divide duration by 5

11 = divide duration by 7

bit 6: dotted note flag (1 = dot)

bit 7: flat modifier (1 = flat); this is used for notation only

at most 1 of the flat or sharp modifiers can be set

bit 8: sharp modifier (1 = sharp); this is used for notation only

at most 1 of the flat or sharp modifiers can be set

bit 9: rest modifier (1 = rest instead of note)

bits 10-11: release point 1 origin

01 = use default origin

10 = measure release point from start of note

11 = measure release point from end of note

other values are not permitted

bits 12-13: release point 2 origin

01 = use default origin

10 = measure release point from start of note

11 = measure release point from end of note

other values are not permitted

bit 14: release point 3 origin (1 = from start instead of end)

0 = release 3 occurs at end of note

1 = release 3 occurs at start of note

bits 15-16: pitch displacement start point origin

01 = use default origin

10 = pitch displacement start point from start of note

11 = pitch displacement start point from end of note

other values are not permitted

bits 19-20: detuning mode

01 = use default treat detuning scale

10 = treat detuning value as half-step number

11 = treat detuning value as hertz

other values are not permitted

bits 21-22: note duration adjustment scale

01 = use default duration adjustment scale

10 = add duration adjustment to the duration

11 = multiply the duration adjustment by the duration

other values are not permitted

bit 23: retrigger envelopes on tie flag

bit 24: portamento linear in hertz instead of half steps (1 = hertz)

all unspecified bits must be zero!

2-byte signed little endian pitch index

should be a value in the range 0..383. Middle C (261.6 Hertz) = 192

2-byte little endian small integer coded decimal portamento duration.

this determines how long a portamento will last, in fractions of a quarter note. it only has effect if the note is the target of a tie. a value of 0 means instantaneous, i.e. no portamento.

A small integer coded decimal is the decimal \* 1000 with a range of -29.999 to 29.999

- 2-byte little endian small integer coded decimal early/late adjustment  
this determines the displacement in time of the occurrence of the note in fractions of a quarter note.
- 2-byte little endian small integer coded decimal duration adjustment  
this value changes the duration of the note by being added to the duration or being multiplied by the duration.
- 2-byte little endian small integer coded decimal release point 1 location  
this determines when the release of the first sustain/loop will occur in fractions of the current note's duration. it is relative to the origin as determined by the opcode field.
- 2-byte little endian small integer coded decimal release point 2 location  
this determines when the release of the second sustain/loop will occur.
- 2-byte little endian small integer coded decimal overall loudness adjustment  
this factor scales the total volume output of the oscillators for this particular note. It is multiplied, so a value of 1 makes no change in loudness.
- 2-byte little endian small integer coded decimal stereo position adjustment.  
this value adjusts where the sound will be located in stereo. -1 is the far left, 1 is the far right, and 0 is center.
- 2-byte little endian small integer coded decimal surround position adjustment.  
this value adjusts where the sound will be located in surround sound.  
1 is front and -1 is rear.
- 2-byte little endian small integer coded decimal accent 1 value
- 2-byte little endian small integer coded decimal accent 2 value
- 2-byte little endian small integer coded decimal accent 3 value
- 2-byte little endian small integer coded decimal accent 4 value
- 2-byte little endian fake pitch value  
this value has a range of -1..383. If it is not -1, then it will be used to determine which sample a multisampled oscillator will use. If it is -1 then the actual pitch will be used to select a sample.
- 2-byte little endian small integer coded decimal pitch disp depth adjustment  
this adjusts the maximum amplitude of the pitch displacement depth oscillator (vibrato). The value has units of either half steps or hertz depending on the setting in the opcode word.
- 2-byte little endian small integer coded decimal pitch disp rate adjustment  
this adjusts the maximum amplitude of the pitch displacement rate oscillator. the units are periods per second.
- 2-byte little endian small integer coded decimal pitch disp start point adjust  
this value adjusts when the pitch displacement envelopes start. the location is from start or end of note, depending on the opcode settings, and is in fractions of the current note's duration.
- 2-byte little endian small integer coded decimal hurry-up factor  
this factor scales the total speed at which all envelopes change. this is multiplicative, so a value of 1 makes no change, and smaller values make transitions go faster.
- 2-byte little endian small integer coded decimal detuning value  
this value is added to the pitch of the note to detune. its units are either hertz or half steps depending on the opcode word.

Remainder of Command Variant Subblock:

lower 31 bits of the command opcode:

- 16 = restore tempo
- 17 = set tempo
- 18 = adjust tempo

19 = sweep tempo absolute  
20 = sweep tempo relative  
32 = restore stereo position  
33 = set stereo position  
34 = adjust stereo position  
35 = sweep stereo position absolute  
36 = sweep stereo position relative  
48 = restore volume  
49 = set volume  
50 = adjust volume  
51 = sweep volume absolute  
52 = sweep volume relative  
64 = restore release point 1  
65 = set release point 1  
66 = adjust release point 1  
67 = set release point 1 origin  
68 = sweep release point 1 absolute  
69 = sweep release point 1 relative  
80 = restore release point 2  
81 = set release point 2  
82 = adjust release point 2  
83 = set release point 2 origin  
84 = sweep release point 2 absolute  
85 = sweep release point 2 relative  
96 = restore accent 1  
97 = set accent 1  
98 = adjust accent 1  
99 = sweep accent 1 absolute  
100 = sweep accent 1 relative  
112 = restore accent 2  
113 = set accent 2  
114 = adjust accent 2  
115 = sweep accent 2 absolute  
116 = sweep accent 2 relative  
128 = restore accent 3  
129 = set accent 3  
130 = adjust accent 3  
131 = sweep accent 3 absolute  
132 = sweep accent 3 relative  
144 = restore accent 4  
145 = set accent 4  
146 = adjust accent 4  
147 = sweep accent 4 absolute  
148 = sweep accent 4 relative  
160 = restore pitch displacement depth  
161 = set pitch displacement depth  
162 = adjust pitch displacement depth  
164 = sweep pitch displacement depth absolute  
165 = sweep pitch displacement depth relative  
176 = restore pitch displacement rate  
177 = set pitch displacement rate  
178 = adjust pitch displacement rate  
179 = sweep pitch displacement rate absolute  
180 = sweep pitch displacement rate relative  
192 = restore pitch displacement start point  
193 = set pitch displacement start point  
194 = adjust pitch displacement start point  
195 = set pitch displacement start point origin  
196 = sweep pitch displacement start point absolute

197 = sweep pitch displacement start point relative  
208 = restore hurry-up factor  
209 = set hurry-up factor  
210 = adjust hurry-up factor  
211 = sweep hurry-up factor absolute  
212 = sweep hurry-up factor relative  
224 = restore detuning  
225 = set detuning  
226 = adjust detuning  
227 = set detuning mode  
228 = sweep detuning absolute  
229 = sweep detuning relative  
240 = restore early/late adjust  
241 = set early/late adjust  
242 = adjust early/late adjust  
243 = sweep early/late adjust absolute  
244 = sweep early/late adjust relative  
256 = restore duration adjust  
257 = set duration adjust  
258 = adjust duration adjust  
259 = sweep duration adjust absolute  
260 = sweep duration adjust relative  
261 = set duration adjust mode  
272 = set meter  
273 = set measure number  
288 = comment  
304 = restore surround position  
305 = set surround position  
306 = adjust surround position  
307 = sweep surround position absolute  
308 = sweep surround position relative  
320 = set transpose  
321 = adjust transpose  
336 = set effect accent 1  
337 = adjust effect accent 1  
338 = sweep effect accent 1 absolute  
339 = sweep effect accent 1 relative  
352 = set effect accent 2  
353 = adjust effect accent 2  
354 = sweep effect accent 2 absolute  
355 = sweep effect accent 2 relative  
368 = set effect accent 3  
369 = adjust effect accent 3  
370 = sweep effect accent 3 absolute  
371 = sweep effect accent 3 relative  
384 = set effect accent 4  
385 = adjust effect accent 4  
386 = sweep effect accent 4 absolute  
387 = sweep effect accent 4 relative  
400 = set global score effect accent 1  
401 = adjust global score effect accent 1  
402 = sweep global score effect accent 1 absolute  
403 = sweep global score effect accent 1 relative  
416 = set global score effect accent 2  
417 = adjust global score effect accent 2  
418 = sweep global score effect accent 2 absolute  
419 = sweep global score effect accent 2 relative  
432 = set global score effect accent 3  
433 = adjust global score effect accent 3

434 = sweep global score effect accent 3 absolute

435 = sweep global score effect accent 3 relative

448 = set global score effect accent 4

449 = adjust global score effect accent 4

450 = sweep global score effect accent 4 absolute

451 = sweep global score effect accent 4 relative

464 = track effects switch

no other values besides these are allowed!

Format of data for each command (not including the 4-byte opcode word):

16 = restore tempo

no arguments

17 = set tempo

4-byte little endian extended integer coded decimal number of beats per minute

an extended integer coded decimal is  $1000 * \text{the decimal value}$ , with

a range of -1999999.999 to 1999999.999

18 = adjust tempo

4-byte little endian extended integer coded decimal beats per minute adjust

19 = sweep tempo absolute

4-byte little endian extended integer coded decimal target beats per minute

4-byte little endian extended integer coded decimal number of beats to reach it

20 = sweep tempo relative

4-byte little endian extended integer coded decimal target beats per minute adjust

4-byte little endian extended integer coded decimal number of beats to reach it

32 = restore stereo position

no arguments

33 = set stereo position

4-byte little endian large integer coded decimal stereo position value

-1 is left, 1 is right, 0 is center

34 = adjust stereo position

4-byte little endian large integer coded decimal stereo position adjustment

35 = sweep stereo position absolute

4-byte little endian large integer coded decimal target stereo position

4-byte little endian extended integer coded decimal number of beats to reach it

36 = sweep stereo position relative

4-byte little endian large integer coded decimal target stereo position adjust

4-byte little endian extended integer coded decimal number of beats to reach it

48 = restore volume

no arguments

49 = set volume

4-byte little endian large integer coded decimal volume level specifier

50 = adjust volume

4-byte little endian large integer coded decimal volume level adjustment

51 = sweep volume absolute

4-byte little endian large integer coded decimal target volume level

4-byte little endian extended integer coded decimal number of beats to reach it

52 = sweep volume relative

4-byte little endian large integer coded decimal target volume level adjust

4-byte little endian extended integer coded decimal number of beats to reach it

64 = restore release point 1

no arguments

65 = set release point 1

4-byte little endian large integer coded decimal release point

66 = adjust release point 1

4-byte little endian large integer coded decimal release point adjust

67 = set release point 1 origin

1-byte origin specifier

0 = from start

1 = from end

68 = sweep release point 1 absolute

4-byte little endian large integer coded decimal target release point  
4-byte little endian extended integer coded decimal number of beats to reach it  
69 = sweep release point 1 relative  
4-byte little endian large integer coded decimal target release point adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
80 = restore release point 2  
no arguments  
81 = set release point 2  
4-byte little endian large integer coded decimal release point  
82 = adjust release point 2  
4-byte little endian large integer coded decimal release point adjust  
83 = set release point 2 origin  
1-byte origin specifier  
0 = from start  
1 = from end  
84 = sweep release point 2 absolute  
4-byte little endian large integer coded decimal target release point  
4-byte little endian extended integer coded decimal number of beats to reach it  
85 = sweep release point 2 relative  
4-byte little endian large integer coded decimal target release point adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
96 = restore accent 1  
no arguments  
97 = set accent 1  
4-byte little endian large integer coded decimal accent value  
98 = adjust accent 1  
4-byte little endian large integer coded decimal accent adjust  
99 = sweep accent 1 absolute  
4-byte little endian large integer coded decimal target accent  
4-byte little endian extended integer coded decimal number of beats to reach it  
100 = sweep accent 1 relative  
4-byte little endian large integer coded decimal target accent adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
112 = restore accent 2  
no arguments  
113 = set accent 2  
4-byte little endian large integer coded decimal accent value  
114 = adjust accent 2  
4-byte little endian large integer coded decimal accent adjust  
115 = sweep accent 2 absolute  
4-byte little endian large integer coded decimal target accent  
4-byte little endian extended integer coded decimal number of beats to reach it  
116 = sweep accent 2 relative  
4-byte little endian large integer coded decimal target accent adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
128 = restore accent 3  
no arguments  
129 = set accent 3  
4-byte little endian large integer coded decimal accent value  
130 = adjust accent 3  
4-byte little endian large integer coded decimal accent adjust  
131 = sweep accent 3 absolute  
4-byte little endian large integer coded decimal target accent  
4-byte little endian extended integer coded decimal number of beats to reach it  
132 = sweep accent 3 relative  
4-byte little endian large integer coded decimal target accent adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
144 = restore accent 4  
no arguments

145 = set accent 4  
 4-byte little endian large integer coded decimal accent value  
 146 = adjust accent 4  
 4-byte little endian large integer coded decimal accent adjust  
 147 = sweep accent 4 absolute  
 4-byte little endian large integer coded decimal target accent  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 148 = sweep accent 4 relative  
 4-byte little endian large integer coded decimal target accent adjust  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 160 = restore pitch displacement depth  
 no arguments  
 161 = set pitch displacement depth  
 4-byte little endian large integer coded decimal pitch disp depth  
 162 = adjust pitch displacement depth  
 4-byte little endian large integer coded decimal pitch disp depth adjust  
 164 = sweep pitch displacement depth absolute  
 4-byte little endian large integer coded decimal target pitch disp depth  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 165 = sweep pitch displacement depth relative  
 4-byte little endian large integer coded decimal target pitch disp depth adjust  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 176 = restore pitch displacement rate  
 no arguments  
 177 = set pitch displacement rate  
 4-byte little endian large integer coded decimal pitch disp rate  
 178 = adjust pitch displacement rate  
 4-byte little endian large integer coded decimal pitch disp rate adjust  
 179 = sweep pitch displacement rate absolute  
 4-byte little endian large integer coded decimal target pitch disp rate  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 180 = sweep pitch displacement rate relative  
 4-byte little endian large integer coded decimal target pitch disp rate adjust  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 192 = restore pitch displacement start point  
 no arguments  
 193 = set pitch displacement start point  
 4-byte little endian large integer coded decimal pitch disp start point  
 194 = adjust pitch displacement start point  
 4-byte little endian large integer coded decimal pitch disp start point adjust  
 195 = set pitch displacement start point origin  
 1-byte start point origin  
     0 = from start  
     1 = from end  
 196 = sweep pitch displacement start point absolute  
 4-byte little endian large integer coded decimal target pitch disp start point  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 197 = sweep pitch displacement start point relative  
 4-byte little endian large integer coded decimal target pitch disp start adjust  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 208 = restore hurry-up factor  
 no arguments  
 209 = set hurry-up factor  
 4-byte little endian large integer coded decimal hurry-up factor  
 210 = adjust hurry-up factor  
 4-byte little endian large integer coded decimal hurry-up factor adjust  
 211 = sweep hurry-up factor absolute  
 4-byte little endian large integer coded decimal target hurry-up factor  
 4-byte little endian extended integer coded decimal number of beats to reach it

212 = sweep hurry-up factor relative  
4-byte little endian large integer coded decimal target hurry-up factor adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
224 = restore detuning  
no arguments  
225 = set detuning  
4-byte little endian large integer coded decimal detuning  
226 = adjust detuning  
4-byte little endian large integer coded decimal detuning adjust  
227 = set detuning mode  
1-byte detuning mode specifier  
0 = hertz  
1 = half steps  
228 = sweep detuning absolute  
4-byte little endian large integer coded decimal target detuning  
4-byte little endian extended integer coded decimal number of beats to reach it  
229 = sweep detuning relative  
4-byte little endian large integer coded decimal target detuning adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
240 = restore early/late adjust  
no arguments  
241 = set early/late adjust  
4-byte little endian large integer coded decimal early/late adjust  
242 = adjust early/late adjust  
4-byte little endian large integer coded decimal early/late adjust adjustment  
243 = sweep early/late adjust absolute  
4-byte little endian large integer coded decimal target early/late adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
244 = sweep early/late adjust relative  
4-byte little endian large integer coded decimal target early/late adjust adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
256 = restore duration adjust  
no arguments  
257 = set duration adjust  
4-byte little endian large integer coded decimal duration adjust  
258 = adjust duration adjust  
4-byte little endian large integer coded decimal duration adjust adjustment  
259 = sweep duration adjust absolute  
4-byte little endian large integer coded decimal target duration adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
260 = sweep duration adjust relative  
4-byte little endian large integer coded decimal target duration adjust adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
261 = set duration adjust mode  
1 byte mode flag  
0 = multiplicative  
1 = additive  
272 = set meter  
4-byte little endian numerator  
4-byte little endian denominator  
273 = set measure number  
4-byte little endian new measure number  
288 = comment  
4-byte little endian length of comment text string  
n-byte comment text string (line feed = 0x0a)  
304 = restore surround position  
no arguments  
305 = set surround position  
4-byte little endian large integer coded decimal surround position value

1 is front, 0 is middle, -1 is rear  
306 = adjust surround position  
4-byte little endian large integer coded decimal surround position adjustment  
307 = sweep surround position absolute  
4-byte little endian large integer coded decimal target surround position  
4-byte little endian extended integer coded decimal number of beats to reach it  
308 = sweep surround position relative  
4-byte little endian large integer coded decimal target surround position adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
320 = set transpose  
4-byte signed little endian half-step change (<0 decreases pitch)  
321 = adjust transpose  
4-byte signed little endian transpose adjustment  
336 = set effect accent 1  
4-byte little endian large integer coded decimal accent value  
337 = adjust effect accent 1  
4-byte little endian large integer coded decimal accent adjust  
338 = sweep effect accent 1 absolute  
4-byte little endian large integer coded decimal target accent  
4-byte little endian extended integer coded decimal number of beats to reach it  
339 = sweep effect accent 1 relative  
4-byte little endian large integer coded decimal target accent adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
352 = set effect accent 2  
4-byte little endian large integer coded decimal accent value  
353 = adjust effect accent 2  
4-byte little endian large integer coded decimal accent adjust  
354 = sweep effect accent 2 absolute  
4-byte little endian large integer coded decimal target accent  
4-byte little endian extended integer coded decimal number of beats to reach it  
355 = sweep effect accent 2 relative  
4-byte little endian large integer coded decimal target accent adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
368 = set effect accent 3  
4-byte little endian large integer coded decimal accent value  
369 = adjust effect accent 3  
4-byte little endian large integer coded decimal accent adjust  
370 = sweep effect accent 3 absolute  
4-byte little endian large integer coded decimal target accent  
4-byte little endian extended integer coded decimal number of beats to reach it  
371 = sweep effect accent 3 relative  
4-byte little endian large integer coded decimal target accent adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
384 = set effect accent 4  
4-byte little endian large integer coded decimal accent value  
385 = adjust effect accent 4  
4-byte little endian large integer coded decimal accent adjust  
386 = sweep effect accent 4 absolute  
4-byte little endian large integer coded decimal target accent  
4-byte little endian extended integer coded decimal number of beats to reach it  
387 = sweep effect accent 4 relative  
4-byte little endian large integer coded decimal target accent adjust  
4-byte little endian extended integer coded decimal number of beats to reach it  
400 = set global score effect accent 1  
4-byte little endian large integer coded decimal accent value  
401 = adjust global score effect accent 1  
4-byte little endian large integer coded decimal accent adjust  
402 = sweep global score effect accent 1 absolute  
4-byte little endian large integer coded decimal target accent

4-byte little endian extended integer coded decimal number of beats to reach it  
 403 = sweep global score effect accent 1 relative  
 4-byte little endian large integer coded decimal target accent adjust  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 416 = set global score effect accent 2  
 4-byte little endian large integer coded decimal accent value  
 417 = adjust global score effect accent 2  
 4-byte little endian large integer coded decimal accent adjust  
 418 = sweep global score effect accent 2 absolute  
 4-byte little endian large integer coded decimal target accent  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 419 = sweep global score effect accent 2 relative  
 4-byte little endian large integer coded decimal target accent adjust  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 432 = set global score effect accent 3  
 4-byte little endian large integer coded decimal accent value  
 433 = adjust global score effect accent 3  
 4-byte little endian large integer coded decimal accent adjust  
 434 = sweep global score effect accent 3 absolute  
 4-byte little endian large integer coded decimal target accent  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 435 = sweep global score effect accent 3 relative  
 4-byte little endian large integer coded decimal target accent adjust  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 448 = set global score effect accent 4  
 4-byte little endian large integer coded decimal accent value  
 449 = adjust global score effect accent 4  
 4-byte little endian large integer coded decimal accent adjust  
 450 = sweep global score effect accent 4 absolute  
 4-byte little endian large integer coded decimal target accent  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 451 = sweep global score effect accent 4 relative  
 4-byte little endian large integer coded decimal target accent adjust  
 4-byte little endian extended integer coded decimal number of beats to reach it  
 464 = track effects switch  
 1 byte mode flag  
     1 = disable  
     0 = enable

**Background Display Subblock Format:**

4-byte little endian number of tracks in the background of this track  
 for each of those:

4-byte index of the track to be in the background  
 the index is respective to the order in which the tracks were loaded  
 from the file, so 0 is the first track, 1 is the second, and so on.