Showgram User Manual

(03/01/2007, V2.20)

A. Introduction

Each 4MP3 Multifunction Show Controller (4MP3-MSC) requires a user supplied Showgram script file. Once the script has been compiled and downloaded into the non-volatile memory of the 4MP3-MSC, complex shows can be scheduled throughout the day or week. Multiple audio and video programs can be played back from the built-in MP3 players, CD players, DVD players, LD players or other devices via serial communication. One or more of the optically isolated digital inputs of the 4MP3-MSC can trigger Showgram events. The optically isolated digital outputs and the relay on board are mapped to Showgram variables that allow easy manipulation of tally lights or other output devices. Multiple 4MP3-MSC units can communicate with each other via the 10BASE-T Ethernet interface. One unit can access or modify other units predefined network variables. Each unit also has a built-in DMX fade engine accepting DMX commands from Showgram running locally or from another unit on the same 10BASE-T network.

Sequences of events are grouped into cues. The 4MP3-MSC runs a cue engine that allows simultaneous execution of all downloaded cues. Each cue consists of one or more simple or compound statements. Bit, integer, floating point and string variables can be created, tested and operated on. Hardware digital inputs, outputs, relay can be defined as bit variables. Serial ports are mapped to string variables. Once defined, the hardware associated with these variables is transparent to the user. Global variables can be accessed and manipulated by all cues while local variables are restricted to the scope of the cue within which the variables are declared.

For the rest of this manual, words in italic form are reserved keywords for the Showgram language. Reserved keywords are case insensitive. However, all user-defined names in the scripts are case sensitive. In Showgram language, all text from two consecutive forward slashes (//) to the end of the line is treated as comments.

B. Cues and The Cue Engine

A cue is an execution unit consisting of one or more statements. There are two kinds of statements. A simple statement consists of a single command followed by a semicolon. A compound statement consists of multiple commands enclosed in a pair of braces:

```
{
        statement1;
        statement2;
        …
        statementN;
}
```

The definition of a cue is

```
Cue myCue
{
        one or more statements
}

or

Cue myCue(variable1,variable2,…,variableN)
{
        one or more statements
}
```

where *Cue* is a keyword and myCue is a user-defined cue name. The second from allows parameters to be passed to the cue. The body consists of one or more command statements enclosed by a pair of braces. Local variables can be defined within the body of a cue, which can only be used by statements forming the body of the cue. All variables defined outside of cues are global in the sense that they can be accessed and manipulated by all cues. Parameter variables are treated as local variables.

There are three ways to start a cue. 1) A cue can be started by another cue using the *CStart* command. 2) An *AutoStart* command can be included in the body of the cue to cause the cue to start automatically when the 4MP3-MSC is powered up or when a scheduled system startup time has arrived. 3) Define a logical expression with the *Enable* statement, which starts the cue whenever the expression is evaluated to *True*. Similarly, there are three ways to stop a cue. 1) A cue can be stopped by another cue with the *CStop* command. 2) Define a logical expression with the *Halt* statement, which stops the cue whenever the expression is evaluated to *True*. 3) A scheduled system stop time has arrived. In addition, a logical expression can be defined with the *Inhibit* statement, which prevents the cue from starting whenever the expression is evaluated to *True*. A *HoldOff* duration can be specified for a cue. A cue enters the *HoldOff* period after the last statement has been executed. During this *HoldOff* period, the cue cannot be restarted. In addition to the global scheduled system start and stop time, the run time of a cue can also be restricted by the *StartTime* and *StopTime* parameters. The *CWait* command allows you to wait for a cue to finish and *CStartW* would start a cue and then wait till it finishes. These start/stop capabilities are extremely useful in sharing resources; scheduling shows and defining relationship between show event. For examples,

```
Cue myCue
{
        Autostart;                  // start on power up or script reload
        CStart myCue1;              // start myCue1 but don't wait
}
Cue myCue2
{
        Inhibit if (!MasterEnable);     // don't run if MasterEnable flag is false
        Enable if (button.down);        // start if button pushed
        Halt if (MuseumClosed);         // halt if the museum is closed
        CStartw myCue1;                 // start myCue1 and wait till it finishes
}
Cue myCue1
{
        Holdoff = 0:1:0.0;              // hold off is 1 minutes
        StartTime = 12:00:00.00;        // only run between noon and 4pm.
        StopTime  = 16:00:00.00;
loop:
        Idle for 30;
        Jump loop;
}
```

The *Inhibit* and *Halt* expression are always checked first and would prevent the cue from starting if either one is *True*, even if the *Enable* expression were *True*.

The *Holdoff*, *StartTime* and *StopTime* of a cue can be accessed and modified as if they are generic *Long* variables. For cue myCue1, the parameter variables are myCue1.*Holdoff*, myCue1.*StartTime* and myCue1.*StopTime*.

The full syntax of the CStart and CStop commands are:

```
CStart <one or more cues separated by commas>;
CStartW <one or more cues separated by commas>;
CStop <one or more cues separated by commas>;
CWait <one or more cues separated by commas>;
```

In addition to addressing a cue directly with the cue name you can also use variables of type *CueVar*.

```
CueVar myCueVar;
```

You can assign a cue name to a *CueVar* or assign another *CueVar* to a *CueVar*. For example,

```
myCueVar = myCue;
```

Once myCueVar is assigned with a cue, you can access all the cue parameters as if you are using the actual cue name. myCueVar.*Holdoff* is the same as myCue.*Holdoff*, etc. The only reason to introduce variables with type CueVar is to allow the user to pick a cue randomly from a list and start/stop the selected cue. The syntax to pick a random cue is

```
<cue var> = oneof (<cue name1>,<cue name2>,…,<cue nameN>);
```

For example,

```
// define some cues here, myCue1, myCue2, myCue3
….
….
Cue myCue
{
        CueVar myCueVar;                          // define a cue variable

        myCueVar = oneof(myCue1, myCue2, myCue3);     // pick one randomly
        // we are not guaranteed to always succeed since all the cues might still be
        // in Holdoff period. If no cue is selected, myCueVar would be set to 0.
        if (myCueVar != 0)
        {
                CStartW myCueVar;                 // start cue and wait
        }
}
```

Each 4MP3-MSC maintains a single cue engine which checks the conditions of each cue, starts and stops the cue accordingly and executes the command statements of a running cue. All the cues are checked and executed one statement at a time in a round-robin fashion by the cue engine. To the users, all the cues appear to be executing simultaneously.

C. Controller Time and Cue Time

The 4MP3-MSC maintains several global time parameters that can be accessed in Showgram. The day of the week is stored in a predefined system integer variable *DayOfWeek*. Sunday is mapped to a value of 1, Monday to 2, Tuesday to 3, etc. The time of day in number of video frames (assuming 30 frames/sec) since mid-night is stored in a predefined system integer variable *Now*, which has a range of 0 to 2591999. The calendar day of the month is in a predefine system integer variable Day. The calendar month is in a predefined integer variable *Month* and the calendar year is in the variable *Year*.

Each 4MP3-MSC has a hardware real-time clock (RTC). It maintains a real calendar time even when the unit is powered off. The RTC time may be synchronized with a host computer, or adjusted from the LCD front panel. The RTC handles daylight saving automatically (for Northern America). At system power up, the global time parameters are set according to the date and time maintained by the real-time clock. Therefore, events may be scheduled according to time of the day, for example, starting up the exhibits at 9am and shutting down at 5pm. *GlobalSchedule* is a predefined system *Bit* variable that can be used to turn on or off this 7-day system-wise schedule. When the 7-day system-wise schedule is enabled, the user may set the system start and stop times for each day of the week. Each cue can be set to follow or not follow this system-wise schedule. When a cue is set to follow the system-wise schedule, it cannot be started when the system time is outside of the scheduled hours. When the system time gets out of the scheduled hours, all running cues that follow the system-wise schedule would be halted. When the system time crosses into scheduled hours, all cues with *AutoStart* enabled and following the system-wise schedule would be started. All cues that do not follow the system-wise schedule may be started or stopped at any time. Cues with *AutoStart* enabled but not following the system-wise schedule would be auto-started only at system power up.

Each cue carries its own time of day clock. The clock can be absolute (declared with the *Absolute* command), meaning that it is the same as the system clock. Or it can be relative (declared with the *Relative* command), meaning that it is offset from the system clock. When a cue is declared as relative, its cue start time (and so the cue clock) is reset to mid-night (zero) when it is started. Each cue has a predefined write-only system integer variable *Reference*. You may change the cue start time (and hence the cue clock) by assigning the new start time to the *Reference* variable. The cue clock, by default, is relative unless the *Absolute* command is added inside the cue body.

The cue clock comes into play when simple statements are time-stamped. A simple statement can be time-stamped by starting the line with an '@' sign followed by a SMPTE time or simply an integer constant. For examples,

```
Cue myCue
{
        Relative;                   // use relative clock
@00:02:03.4   myVal = 0;            // wait until the cue clock is 00:02:03.4
@1234         myVal = 1;            // wait until the cue clock is 1234 frames
        Reference = 0;              // reset the cue clock to zero
@00:01:02.3   myVal = 2;
}
```

When the cue engine encounters a simple statement with an '@' time stamp, it checks the cue clock and won't execute that statement until the clock is the same or beyond the time stamp. Since all SMPTE times are converted to integer frames, the time stamps may be in either format. Time stamping becomes handy when dealing with video events. For example, assume that we have to play a video from a laser disc player starting at frame 1000 and toggle the relay when the laser disc player reaches frame 5000 and 10000. It can be coded as

```
        Cue myCue
        {
                Bit theRelay = relay1;          // map relay 1 to a Bit variable
```

```
                        Relative;
                        // add more statements to search to frame 1000 here
                        // add a statement to start the laser disc player here
                        Reference = -1000;    // reset time reference to match video start
        @5000           theRelay = 1;         // up relay
        @5030           theRelay = 0;         // lower relay to generate a 1 second pulse
        @10000          theRelay = 1;         // wait again
        @10030          theRelay = 0;         // lower relay to generate a 1 second pulse
                        // add some statements to wait till video is over
                        //      and stop the player here
                }
```

An alternate timestamp is the ‘*’ timestamp. When the cue engine encounters a statement with an ‘*’ timestamp, it checks the cue clock and won’t execute that statement until the clock is the same as the timestamp. If the clock is already beyond the timestamp, that statement would be skipped. For example,

```
                Cue myCue
                {
                        Autostart;
                        Absolute;                    // use true time of the day clock
        *00:08:00.00     CStart Show;
        *00:09:00:00     CStart Show;
        *00:10:00:00     CStart Show;
        *00:11:00:00     CStart Show;
        *00:12:00:00     CStart Show;
                }
```

If ‘myCue’ is started at 9:45am, the statements at *00:08:00.00 and *00:09:00.00 would be skipped and the Show won’t run until 10am. If the ‘@’ timestamps were used, the Show would be started twice immediately upon starting of myCue at 9:45am. This is extremely useful when the 7-day system-wise schedule is enabled. You may change the daily start time from the LCD front panel without requiring reprogramming of the scripts. Using the ‘*’ and ‘@’ timestamps together, you can make sure that critical events got executed and irrelevant events skipped when you fast forward in time. When the ‘*’ timestamp is used with a compound statement, the *While*, *If*, *If-Else*, *In* and *For* statements, the entire compound statement would be skipped if the timestamp has already expired.

The elapsed time since the beginning of a cue can be retrieved with the *Elapsed()* function, without an argument. You may also calculate the time elapsed from an earlier instant by providing an argument to the *Elapsed* function. For examples,

```
        Int lastTime, duration;        // declare temporary variables
        lastTime = Elapsed();          // get the elapsed time since the cue started
        // do something here
```

```
lastTime = Now;                   // get the current time
// as an example, we just sit idle for a while, but you can do something else here
Idle for 300;                     // wait for 10 seconds
lastTime = Elapsed(lastTime);  // duration will be set to 300
```

Each controller is also equipped with a SMPTE timecode input and an output. There is a predefined Bit variable, *runTimeCode*, that turns on/off of the timecode output. A *Long* variable, *timeCodeOut*, can be used to initialize the timecode before turning on the output. For example,

```
timeCodeOut = 01:00:00.00;
runTimeCode = TRUE;
```

would initialize and then turn on the timecode output. Chasing of SMPTE timeocde input is not yet supported.

D. Literal Constants, Variables and Operators

Logical constants can be *True* or *False*. Non-zero values imply *True* and 0 implies *False*. Integer constants can be any values between –2147483648 to 2147483647, or in hexadecimal format between 0x0 and 0xFFFFFFFF. 0x must precede all integer constants in hexadecimal format. For example, 0x10 is a hexadecimal representation of 16. Integer constants can also be entered in the SMPTE format. For example, 00:01:00.15 will be automatically converted to 1815, the equivalent number of video frames assuming a frame rate of 30 frames per second. Floating-point constants must either contain the decimal point '.', or in the mantissa-exponential form with 'e' or 'E' separating the mantissa and the exponent. For examples, 1.0, 1.0e3 and 2.54E-4 are all valid floating-point constants. Constant strings are one or more ASCII characters enclosed by "". This definition does not allow constant strings to contain the character ". However, a string containing one or more " can be created with embedded hexadecimal strings. For example, the hexadecimal string &22 in a string "abc&22def" will be converted by the compiler to a single " character. All embedded hexadecimal strings must consists of an "&" followed by two hexadecimal digits. Therefore, a carriage return character is &0D while a blank space is &20.

A constant string can also be created with the *ByteStr* operator. The syntax is

```
ByteStr(integer1, integer2, …, integerN)
```

Where integer1, integer2, …, integerN are constant integers between 0 and 255. For example, ByteStr(48, 0x41, 0x61) is equivalent to the string "0Aa".

Showgram supports 6 kinds of variables, *Bit, Integer(or Long), Float, String, CueVar and ClipVar*. See other sections for the descriptions of *CueVar* and *ClipVar*.

A logical variable can be defined with the *Bit* declaration statement. For example,

```
Bit myBit, dogBarking, motionSensor;
```

where myBit, dogBarking and montionSensor are three user defined names. A bit variable takes on two values, *True* or *False*. The following logical operators are supported for *Bit* variables:

1. &&   - logical AND
2. || - logical OR
3. !   - logical NOT

The operator precedence is !, &&, followed by ||. Therefore, the expression !myBit1 || myBit2 will be evaluated as the logical OR of NOT myBit1 with myBit2. Similarly, A && B || C will be evaluated as logical OR of C and the logical AND of A and B.

In addition to being *True* or *False*, a *Bit* variable also carries two other states, an *Up* state and a *Down* state. The *Up* state is set to *True* whenever the variable changes its value from *False* to *True*. Similar, the *Down* state is set to *True* whenever the variable changes value from *True* to *False*. The *Up* and *Down* state remain *True* once set to *True* until they are test. Once tested, the state reverts back to *False*. The *Up* state can be tested by appending the *.Up* extension to the parent variable. Similarly, the *Down* state can be tested by appending the *.Down* extension. For example,

```
myBit = True;
myBit = False;          // myBit Down state is set to True
myBit = True;           // myBit Up state is set to False
myBit1 = myBit.Up;   // myBit1 is set to True, the Up state of myBit is set to False
myBit1 = myBit.Down; // myBit1 is set to True, the Down state of myBit is now False
```

The significance of the *Up* and *Down* states become apparent when the *Bit* variable is mapped to one of the optically isolated inputs with a physical button attached. When the *Down* state is *True*, then the button has been pushed at least once. When the *Up* state is *True*, then the button has been released at least once.

Bit variables may be initialized or mapped in the declaration statement. For examples,

```
Bit myBit = True;
Bit myBit1 = False;
```

To access the optically isolated inputs, outputs and the relay, just map them to Bit variables:

```
Bit sensor1 = Din1;                 // digital input #1 is now called sensor1
Bit tripped = Din1;                 // digital input #1 is also referred to as tripped.
Bit powerSequencer = Relay; // relay will turn on or off the power sequencer
Bit tally2 = Dout2;                 // digital output #2 is now called tally2
Bit upButton = upkey;
Bit downButton = downKey;
Bit leftButton = leftKey;
Bit Rightbutton = rightKey;
Bit middleButton = enterKey;
```

Now you can turn on the tally light and the power sequencer when the sensor is tripped as:

```
If (tripped.Down)
{
        powerSequencer = True;
        tally2 = True;
}
```

The reserved words *Din1*, …, *Din24*, *Dout1*, … *Dout24*, *Relay1* and *Relay2* refer to the 24 optically isolated inputs, the 24 optically isolated outputs and the two relays. There are actually only 24 physical I/O pins. Each pin serves as both input and output. Therefore, *Din1* and *Dout1* refer to the same physical I/O pin. You may use each pin strictly as input or straightly as output throughout the scripts. Or you may use them simultaneously by declaring the "*.io*" property to be true (sensor1.io = TRUE). When an I/O pin is declared as "*.io*" true, the output driver is disabled momentarily periodically to allow the input state to be read. Therefore, if you connect a button together with a tally light to the same I/O pin, the tally light will be turned off very briefly to allow the button state to be read. The turnoff time is so brief that the tally light would not appear as blinking. You should avoid using simultaneous I/O when the external device to be controlled cannot tolerate glitching of the 4MP3-MSC outputs.

The five keywords *upKey*, *downKey*, *rightKey*, *leftKey* and *enterKey* refer to the up, down, right, left and center keys, respectively, of the keypad on the front panel of the controller. Bit variables declared with these keywords have valid values only when the controller front panel LCD display is in script output mode. These keywords allow the front panel keypads to be used as generic digital input. They are typically used to activate startup and shutdown cues. Immediately after power up, the controller's front panel LCD and keypad are in menu mode. While in menu mode, the keys on the keypads are used to traverse the menu tree. The user can put the front panel LCD and keypad in script output mode by selecting the USR option on the top level menu. The unit also goes into script output mode if the keypad has not been used for 30 or more seconds.

Integer variables can be declared with the *Int or the Long* keywords. Integer variables are 32-bit in length, providing a valid representation range of –2147483648 to 2147483647.
For examples,

```
Int myValue;
Long counter = 3;               // initialize to 3
```

The following operations are supported:

a. + - addition
b. - - subtraction
c. * - multiplication
d. / - division
e. % - modulus
f. & - bit-wise AND
g. | - bit-wise OR
h. ^ - bit-wise exclusive OR
i. ~ - bit-wise complement
j. << - left shift
k. >> - righ shift
l. += - addition assignment
m. -= - subtraction assignment
n. *= - multiplication assignment
o. /= - division assigment
p. %= - modulus assignment
q. &= - bit-wise AND assigment
r. |= - bit-wise OR assignment
s. ^= - bit-wise exclusive OR assignment
t. <<= - left shift assignment
u. >>= - right shift assignment

The operator precedence is (~, negation), (*, /, %), (+, -, <<, >>), &, ^ followed by |. Operators grouped by parentheses have equal precedence. Operators with equal precedence are evaluated from left to right unless grouped by parentheses. The operator += is interpreted as adding the result of the right hand expression to the variable on the left hand side of the operator. For example,

```
var1 += var2;
```

is equivalent to

```
var1 = var1 + var2;
```

The same interpretation applies to the other operator-assignment operators.

Floating-point variables can be defined with the *Float* keyword. For examples,

Float myFloat1, myFloat2;
Float myfval = 1.2;   // initialized to 1.2

Floating-point variables are implemented in 32-bit IEEE format. The supported operators are:

a. + - addition
b. - - subtraction
c. * - multiplication
d. / - division
e. % - modulus
f. += - addition assignment
g. -= - subtraction assignment
h. *= - multiplication assignment
i. /= - division assignment
j. %= - modulus assignment

The operator precedence is (*, /, %) followed by (+, -). Operators with equal precedence are evaluated from left to right unless grouped by parentheses.

String variables can be declared with the *String* keyword. For examples:

```
String myStr1, myStr2;
String constStr = “abc”;          // initialized to “abc”
```

To send to and receive from the serial ports of the 4MP3-MSC, map the serial ports to string variables. For example:

```
String laserDisc = port1;         // port 1 is connected to a laser disc player
String toPC = port2;              // port 2 is connected to a PC
String ledSign = port3;           // port 3 is controlling an LED sign
```

The maximum number of characters allowed in a string is 255. Strings may be concatenated with the ‘+’ operator. Substring and number-string conversion functions are also supported and will be discussed in the Command Reference section.

Arrays of *Bit*, *Int* and *Float* variables may be declared as:

```
Bit myBits[10];                   // an array of 10 bit variables
Int myInts[10];                   // an array of 10 integer variables
Float myFlts[10];                 // an array of 10 floating variables
```

Arrays can also be initialized at declare time:

```
Float myFlts[10] = {1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0};
Bit myBits[10] = {True, False};
```

Any un-initialized members are set to 0 for *Float* and *Int* arrays, FALSE for Bit arrays.

Once declared, individual elements of an array may be addressed with the [] brackets. For examples,

```
If (myBits[2]) jump loop;            //
myInts[3] = 1234;
myFlts[2*index+3] = 456.0;           // index is an integer variable
```

All variables are categorized as global or local. All variables declared outside the body of a cue are global. All variables declared inside a cue are local to that cue. Global variables can be referred to in any statements throughout the script file. Local variables can only be referred to inside the body of the cue in which the variables are declared. One cue cannot access a local variable declared inside another cue. When a local variable has the same name as a global variable, statements inside the cue in which the local variable is declared would always access the local version of that variable. When variables are declared without initialization, the follow defaults are assumed:

Bit	– default to False
Int	– default to 0
Float	– default = 0.0
String	– default to a null string

E. String/Serial Port Manipulations

String variables can be declared with the *String* keyword. For examples:

```
String myStr1, myStr2;
String constStr = “abc”;             // initialized to “abc”
```

The maximum number of characters allowed in a string is 255. Strings may be concatenated with the ‘+’ operator. For example,

```
myStr1 = myStr2 + constStr;
```

You may also add a String and an integer variable together. The effect is to add the least significant byte of the integer variable to the string. For example,

```
myStr1 =  “Hi there”;
myInt = 0x9;                         // horizontal TAB
myStr2 = myStr1 + myInt + “How are you?”;
```

The resulting string would be “Hi there<tab>How are you?”. The String/Integer addition together with the *FMT* command allows you to create any arbitrary ASCII or binary strings on the fly.

You may extract a substring of a string with the *.substr* member function. The .substr member function requires two arguments, the starting location and the ending location. Both arguments may be integer constants or integer expressions. For examples,

```
myStr1 = constStr.substr(1,2);              // extract “ab” from constStr
myStr1 = constStr.substr(index,index+3);    // where index is an integer variable
```

Individual character of a string can be accessed with the [] index operator. When applied to a string, the [] index operator returns an integer equal to the ASCII value of the character at the given index location. For example,

```
myInt = constStr[2];                        // myInt will be set to 0x62
```

However the following is not allowed:

```
constStr[2] = 0x30;                         // this is NOT ALLOWED!!!
```

The member property *.len* returns the length of the string and can be treated as if it is a read only integer variable. For example,

```
myInt = constStr.len;                       // myInt would be set to 3
```

To find a string inside a string, use the *.Find* member function. If the string is found, the .find member function returns the position of the first character of the sub-string found. Zero will be returned if the sub-string is not found. For example,

```
myStr = “abcdefgh”;
myInt = myStr.Find(“cde”);                  // myInt will be set to 3
myInt1 = myStr.Find(“ijk”);                 // myInt1 will be set to 0
```

A string can be converted to an integer or a floating point number with the *Atoi* and the *Atof* functions. An implicit Atoi or Atof will be assumed if a string is assigned to an integer variable or a floating point variable.
For example,

```
myStr = “123”;
myInt = Atoi(myStr) + 1;                    // myInt will be set to 124
myFloat = 2.0 * Atof(myStr);                // myFloat will be set to 246.0
myInt1 = myStr;                             // an implicit Atoi sets myInt1 to 123
myFloat1 = myStr;                           // an implicit Atof sets myFloat1 to 123.0
```

The *.Format* member function allows creation of a string from other variables. The syntax is identical to the sprintf function in C and C++, but only one variable can be specified. Please consult a C programming language reference book on the various format strings allowed. For example,

```
myStr.Format("Current count = %ld", myInt);
```

If myInt has a value of 123, then myStr will be set to "Current count = 123". Since all integer variables are treated as Long integers by the 4MP3-MSC firmware, therefore, the %ld format string is required. Note that C language escape characters like '\n' and '\r' are not support. Instead, use the embedded hexadecimal strings:

```
myStr.Format("Current count = %ld&0D&0A", myInt);
```

will add a carriage return and a linefeed to the string. To overcome the limitation of allowing only one variable in a *.Format* statement, you may concatenate multiple strings created with the *fmt* function. The syntax of the *fmt* function is the same as the *.Format* member function. However, it creates a new temporary string instead. For examples:

```
myStr =  fmt("Current count = %ld, ", myInt) + fmt("Average = %4.2f", myFloat);
```

If myInt has a value of 123 and myFloat of 4.0, then myStr will become "Current count = 123, Average = 4.00".

To send to and receive from the serial ports of the 4MP3-MSC, map the serial ports to string variables. For example:

```
String laserDisc = port1;          // port 1 is connected to a laser disc player
String toPC = port2;               // port 2 is connected to a PC
String ledSign = port3;            // port 3 is controlling an LED sign
```

These serial-port-mapped string variables behave exactly like ordinary string variables. All the functions and member functions described above may be applied to these serial-port-mapped string variables. In addition, they support several other member properties and one other member function. The *.Empty()* member function without an argument empties the serial port receive buffer. When an integer expression is specified as an argument, the expression will be evaluated to give the number of characters to be removed from the serial port receive buffer. For example,

```
laserDisc.Empty();                 // empty the receive buffer
laserDisc.Empty(3);                // remove the first 3 characters in the buffer
```

One caution about serial-port-mapped string variables is that every time the string variable is referenced (except with the *.Find* member function and the [] index operator), a number of characters would be emptied from the receive buffer. The number of characters emptied equals to the length of the string. Therefore, if the input will be used in multiple command statements, it is important to copy the input from the serial-port-mapped variable to a non-serial-port-mapped variable. For example,

```
String projector = port1;            // port 1 connected to a projector
String str;                          // a string variable
If (projector.len > 0)
{
        str = projector;             // copy the input from the projector first
        // do something else with str here
}
```

The serial port parameters can be set with several member properties. The *.type* member property is used to specify the serial port type. The supported types are *LD* (for a Pioneer laser disk player or a Pioneer DVD player) and *ASCII*. The LD type will be described in a later section. The default type is *ASCII* for generic devices. The *.type* member property is a write-only property, i.e., it can only be used on the left hand side of an assignment statement. For example,

```
laserDisc.type = LD;
```

The *.baud* member property is used to specify the baud rate of the serial port. The supported baud rates are 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200. The default rate is 9600 for port 1 and 2, and 115200 port3 and hence the host port. The *.baud* member property is a write-only property, i.e., it can only be used on the left hand side of an assignment statement. For example,

```
laserDisc.baud = 9600;
```

The *.csize* member property is used to specify the number of bits in each transmitted character. The supported values are 5, 6, 7 and 8 for port 1 and 2, and 8 only for port 3. The default is 8. The *.csize* member property is a write-only property, i.e., it can only be used on the left hand side of an assignment statement. For example,

```
laserDisc.csize = 8;
```

The *.stopbit* member property is used to specify the number of stopbits in each transmitted character. The supported values are 1 and 2 for port 1 and 2, and 1 only for port 3. The default is 1. The *.stopbit* member property is a write-only property, i.e., it can only be used on the left hand side of an assignment statement. For example,

```
laserDisc.stopbit = 1;
```

The *.parity* member property is used to specify the port parity. The supported values are *None, Odd, even, Mark* and *Space* for port 1 and 2, but *None* only for port3. The default is *None*. The .parity member property is a write-only property, i.e., it can only be used on the left hand side of an assignment statement. For example,

```
laserDisc.parity = Even;
```

The *.485* member property, when assigned to TRUE, sets the port to RS485 mode. When a port is in RS485 mode, its output driver is automatically turned off after the last byte of a string has been sent out. The driver is re-enabled automatically before the first byte of the next string to be sent.

Most serial port communication protocols use a specific character to signify the end of each command. Such termination character make parsing of the serial input easier. You may inform the 4MP3-MSC which character to use with the *.terminator* member property. The default is no terminator character. For example,

```
laserDisc.terminator = 0xD;          // the terminator is the carriage return
laserDisc.terminator = '.';          // the terminator is the period
```

Once a terminator is specified, the behaviors of the some of the serial port member functions change. For example, when no termination character has been specified, the *.len* member property returns the number of characters received and waiting in the receive buffer. However, when a termination character has been specified, it returns the number of character in the receiver buffer from the first received character to the first termination character. If no termination character has been received, *.len* returns zero. Also, when the corresponding serial-port-mapped string variable is accessed, its content will consist of the received characters up to and including the first termination character. Consider the following script segment:

```
String str;                          // a temporary string
Int tmp;                             // temporary integer variable
String laserDisc = port1;            // map string to port1
laserDisc.terminator = 0xD;          // specify a termination character
// if we now receive the following string in port 1 "abcdef&0Dghijk"
// &0D is just an embedded string representation of 0xD, the carriage return
If (laserDisc.len != 0)              // this is true because laserdisc.len = 7
                                     // abcdef + the termination character
{
        str = laserDisc;             // str would become "abcdef&0D"
                                     // and 7 characters would have been
                                     // removed from the receive buffer
        tmp = laserDisc.len;         // tmp would be zero since the receive
                                     // buffer would now consists of ghijk,
                                     // no termination character detected.
}
```

The *.Reset()* member function resets the corresponding serial port. The send and receiver buffers will be emptied and serial port hardware is initialized.

When the *.SetMSB* member property is true, all bytes transmitted out of the serial port would have the most significant bit set to 1. This is useful when communicating with the Prolink port of an AMX Radia dimmer.

F. Video Laser Disk Control Commands

To facilitate easy control of Pioneer laser disc and DVD players, a set of dedicated commands are included in the script language. The 4MP3-MSC communicates with a Pioneer laser disc or a DVD player via a serial port. The serial port type must be set to *LD*. For example,

```
String laserDisc = port1;          // assuming that the player is on port 1
laserDisc.baud = 9600;             // set baud rate
laserDisc.type = LD;               // set to laser disc
```

There are two kinds of script commands related to Pioneer players, asynchronous and synchronous commands. An asynchronous command sends the Pioneer command to the player and returns the control right back to the script engine. A synchronous command would not return until the response from the player has been received. The difference in syntax is that a synchronous command has the same name as the corresponding asynchronous command but ending with an additional ‘w’. Each command can also be expressed in two different formats. The command are:

1. ***VStart and VStartw*** **–** spin up the player

   For examples,

   ```
   laserDisc.vstart();        // asynchronous dot-member function format
   VStartw laserDisc;         // synchronous direct command format
   ```

2. ***VStop and VStopw*** **–** spin down the player

   For examples,

   ```
   laserDisc.vstop();         // asynchronous dot-member function format
   VStop laserdisc;           // asynchronous direct command format
   ```

3. ***VPause and VPausew*** **– pause the player, screen will be blanked**

   For examples,

   ```
   laserDisc.vpause();        // asynchronous dot-member function format
   VPausew laserDisc;         // synchronous direct command format
   ```

4. ***VStill and VStillw*** **– freeze frame the player, last image on screen**

   For examples,

   ```
   laserDisc.vstillw();       // synchronous dot-member function format
   VStill laserDisc;          // asynchronous direct command format
   ```

5. ***VSearch and VSearchw* – search to the specified location**

   VSearch and VSearchw require one argument. The argument can either be an integer expression or a string expression. The Pioneer players support multiple kinds of search unit. For example, the laser disc players support frame, track block or time search. The DVD players support frame, chapter or SMPTE search. For the laser disc players, the power up default is usually in frames and for the DVD players in chapter. When an integer argument is specified, the search is performed in the currently active search mode. On contrary, a search mode can be specified in a string expression argument. For example,

```
        laserDisc.vsearch(1000);       // search to frame 1000 if frame mode is active
                                       // asynchronous dot-member function format
        VSearchw laserDisc to “FR1000”;     // search to frame 1000
                                       // synchronous direct command format
        laserDisc.vsearchw(“CH2”);  // search to chapter 2
                                       // synchronous dot-member function format
```

6. ***VSend* and *VSendw* – send a generic string to the player**

   VSend* and *VSendw require one argument, a string expression. The value of the string expression is sent directly to the player. This is useful when you need to control the player with commands that are not directly supported by other Showgram video-related commands. The following commands set the stop marker to frame 1234 and then start the playback.

```
        VSend “1234SM PL” to laserdisc;
        laserdisc.VSendw(“1234SM PL”);
```

When the player is playing, paused or stilled, the current playback location can be obtained with the *.frame*, *.time*, *.block*, *.track* or *.chapter* member properties. Not all these member properties return a valid result. The validity depends on which search formats are supported by the player and the disc. For example, a laser disc player would not support the *.chapter* property. CLV and CAV laser discs would support different sets of properties. Note that all these location member property command are synchronous, i.e., the cue engine would wait till the player has returned the location before proceeding to the next command. For example,

```
VSearchw laserDisc to 1000;          // search to frame 1000
If (laserDisc.frame != 1000)         // is it really there
{
        VSearchw laserDisc to 1000;  // try one more time
}
```

There are a set of command are created specifically for multiple Pioneer players to be connected to the same 4MP3-MSC controller and be started simultaneously. The *Hold* function will put on hold the sending of characters out of one or more serial port. All subsequent strings send to the ports currently on hold will be kept in the send buffer waiting to be sent. The Release function releases the specified serial ports and allow those ports to send out the content of their send buffers. For example,

```
ld1 = port1;
ld2 = port2;
ld1.type = LD;
ld2.type = LD;
Hold(ld1, ld2);        // put both ports on hold
ld1.vplay();           // send a play command to ld1, player won't start yet
ld2.vplay();           // send a play command to ld2, player won't start yet
FrameSync;             // idle till the clock ticks to the next video frame
Release(ld1,ld2);      // now send to the two players as close together as possible
```

FrameSync is a command to put the cue on idle until the 4MP3-MSC system clock ticks to the next video frame (the next 1/30th of a second).

G. Network Variables and Network Commands

Each 4MP3-MSC has a set of predefined variables that can be accessed by other units via the 10BASE-T network. To access another units variables, declare a variable with the following format:

<variable type> <variable name> = <mapping keyword>@<IP address>

<variable type> is one of *Bit*, *Long* or *Float*. Variable name is a user defined name. <mapping keyword> is one of the follow:

1. *netBit1*, *netBit2*, … , *netBit10* – 10 predefined general purpose *Bit* variables. Variables are readable and writable.
2. *netLong1*, *netLong2*, …, *netLong10* – 10 predefined general purpose *Long* variables. Variables are readable and writable.
3. *netFloat1, netFloat2, …, netFloat10* – 10 predefined general purpose *Float* variables. Variables are readable and writable.
4. *volume* – global audio volume in dB, type *Float*. Variable is readable and writable.
5. *adc1, adc2, adc3* and *adc4* – 4 predefined integer variables corresponding to the values of the 4 hardware ADC channels. Variables are readonly.
6. *lampPower* – lamp power voltage in volts, type Float. Variable is readonly.
7. *isoPower* – ADC reference voltage at the ADC DB9 connector, type *Float*.
8. *globalSchedule* – 7-day global schedule enable/disable, type *Bit*.
9. *din1,din2,…, din24* – the 24 digital inputs, type *Bit*. Variables are readonly.
10. *dout1, dout2, …, dout24* – the 24 digital outputs, type *Bit*. Variables are readable and writable.
11. *relay1* and *relay2* – the two hardware relays, type *Bit*. Variables are readable and writable.

For examples,

```
Bit remoteRelay = relay1@192.168.1.2;
remoteRelay = TRUE;
```

maps remoteRelay to *relay1* of the unit with IP address 192.168.1.2 and turn on that relay. You can also change the global audio volume of another unit according to a potentiometer attached to ADC1.

```
Float remoteVolume = volume@192.168.1.2;
remoteVolume = - adc1 * 0.003;          // set remote unit’s volume based on
                                        // the potentiometer at ADC1.
```

Similarly, you can set the global audio volume according to a potentiometer attached to ADC1 of a remote unit.

```
Float pot = adc1@192.168.1.2;           // map pot to ADC1 of unit with
                                        // IP address 192.168.1.2
volume = - pot * 0.003;                 // set local volume
```

Using the *.up* and *.down* states of a remote bit variable are not recommended since multiple units might try to access these states and only one unit will detect the transition since the transition state is cleared as soon as it is read. Instead, the remote unit hosting this remote bit variable should push to all the units interested in getting the *.up* and *.down* transitions. The following is not recommended:

```
Bit remoteIn1 = din1@192.168.1.2;
If (remoteIn1.down)
{
        // do something here
}
```

Do the following instead:

```
// on the local unit with IP 192.168.1.3
if (netBit1.down)
{
        // do something here
}

// on unit 192.168.1.2
Bit remoteIn1 = netBit1@192.168.1.3
Bit myDin1 = din1;                      // map myDin1 to digital input 1
if (myDin1.down)
{
        remoteIn1 = FALSE;              // bring the remote variable down
                                        // to create a down transition.
```

```
    }
    if (myDin1.up)
    {
        remoteIn1 = TRUE;                // bring it back up
    }
```

Network bandwidth consumption must be considered when network variables are used. A pushing scheme is preferable to a polling scheme. For example, the following polling scheme is not recommended.

```
        Bit remoteIn1 = din1@192.168.1.2;
    Loop:
        If (remoteIn1 == FALSE)
            Jump Loop;
        // otherwise do something here
```

Every access of remoteIn1 would generate two network packets. If remoteIn1 is TRUE all the time, a continuous stream of network packets would be generated and uses up the network bandwidth. If a polling scheme must be used, then try to slow down the polling by inserting idle time between polls:

```
    Bit remoteIn1 = din1@192.168.1.2;
    Loop:
        If (remoteIn1 == FALSE)
        {
            idle for 5;                  // polls 6 times a second
            Jump Loop;
        }
        // otherwise do something here
```

A pushing scheme can be implemented as following. On the client with IP address of 192.168.1.3 we poll netBit1.

```
    Loop:
        If (netBit1 == FALSE)
            Jump loop;
        // otherwise do something
```

On unit 192.168.1.2 where Din1 is hosted, we do

```
    Bit myDin1 = din1;
    Bit remoteDin1 = netBit1@192.168.1.3;
    Loop:
        If (myDin.down || myDin.up)
            remoteDin1 = myDin1;         // update remote only when we have
                                         // a change in state
```

jump loop;

A generic UDP packet can also be sent to a remote host. The syntax is

UDP@<IP Address>,<Port Number> = “stuff to be sent”;

Where <IP Address> is the IP address of the remote host and <Port Number> is the UDP port to send the packet to. For example

UDP@192.168.1.2,1024 = “Hi there”;

would send the string “Hi there” to port 1024 of the host at 192.168.1.2. Non-displayable numbers can be sent in the &nn format. For example the above can be sent as

UDP@192.168.1.2,1024 = “&48&69&20&74&68&65&72&65”;

Or

UDP@192.168.1.2,1024 = *ByteStr*(0x48,0x69,0x20,0x74,0x68,0x65,0x72,0x65);

When DMX lighting commands are being sent from multiple controllers, we do not have to merge the DMX output of all the units before sending to the lighting controller. Only one unit is required to be physically connected to the lighting controller. All the other units can send DMX commands to this particular unit via the 10BASE-T network. The syntax is

DMX@<IP Address> = “DMX command”;

For example,

```
DMX@192.168.1.2 = “C1-10@30F60”;        // Fade channels 1 to 10 to
                                        // level 30% in 2 seconds
```

The DMX command syntax is described in the next section.

H. DMX Commands

Each 4MP3-MSC unit has a built-in DMX fade engine and a dedicated DMX serial port. DMX fade commands can be sent from Showgram script or from a UDP packet sent via the 10BASE-T network as described in the previous section. The basic fade command is

DMX = “<channel specifications>@<channel level in percents>F<fade time>D<delay time>”

or <channel specifications>@<channel level in percents>T<fade time>D<delay time>

Channel specifications starts with the letter ‘C’ follow by a list of channel numbers or a range of channels. A list of channels are separated by commas. For example,

```
C1,3,5
```

specifies channel 1, 3 and 5. A range is defined by starting number followed by ‘-‘ and then followed by the ending number. For example,

```
C1-10
```

Specifies channels 1 through 10. You may also combine the two formats

```
C1,3,5,7-10
```

to specifies channels 1, 3, 5 and then 7 through 10.

<channel level> is simply the level in integral percents. When the <fade time> is preceded by ‘F’, the unit is in number of frames assuming 30 frames per second. When it is preceded by ‘T’, the unit is multiple of 0.1 second. So F30 and T10 both imply 1 second of fade time. The <delay time> has the same unit as the fade time and is the amount of delay before the fade starts.

Examples,

```
DMX  = “C1,3,5,7-10@30F90”;      // fade the channels to 30% in 3 seconds
DMX = “C1,3@20T30D30”;           // wait for 1 second,
                                 // fade 1 and 3 to 20% in 3 seconds
DMX = “C5-10@100”;               // turn channels 5 to 10 full immediately
```

You can also specify multiple <Channel specifications>@<channel level> in the same command. For example,

```
DMX = “C1,3@10,C5-7@30F30”;    // 1 and 3 to 10%, 5 to 7 to 30% in 1 second
```

Channels are faded based on last action. Therefore if you send in two commands one immediately after another

```
DMX = “C5@10F30”;
DMX = “C5@30F50”;
```

Channel 5 would be faded to 30% in 50 frames.

For MP3 UCC version 2.09 and above, the level syntax has been changed.

DMX = “<channel specifications>@<channel level between 0 and 255>F<fade time>D<delay time>”
DMX = “<channel specifications>%<channel level in percents>F<fade time>D<delay time>”

Use ‘@’ to specify level between 0 and 255 and ‘%’ to specify level in percents.

I. Clips and MP3 Playback

MP3 audio clips are stored in a Compact Flash card. On power up or when the card is plugged in, the controller reads in the directory. However, in order to play a given MP3 file, a clip must be defined in the script identifying the file. Clips must be defined in the Global context, i.e., not inside any cues. The syntax for defining a clip is

```
Clip myClip
{
        Filename = “myclip.mp3”;              // filename of clip
        Dsc = “this is my clip description”;  // just a description
        StartTime = 00:00:10.00;              // start at 10 seconds into the file
        StopTime = 00:02:00.00;               // stop 2 minutes into the file
        Holdoff = 00:10:00.0;                 // hold off of 10 minutes
        Gain = -3.0;                          // -3.0 dB in volume
}
```

All parameters except *Filename* are optional. When *StartTime* and *StopTime* are not specified, the entire file will be played. The optional parameters are also generic parameters that can be accessed and manipulated in the script. For example, myClip.*Dsc* is a generic String variable, myClip.*StartTime*, myClip.*StopTime* and myClip.*Holdoff* are generic Long variables. The *Gain* parameter specifies a clip specific playback volume to cope with situations where not all the clip files are normalized to the same level. This is not enforced by the controller automatically. It is up to the user to set the mixer input level with this parameter before playback starts.

In addition, each clip also has two other readonly type *Long* parameters. The *LastStart* parameter is set to the time at which the clip was last started and the *Len* parameter is the length of the audio file in number of frames assuming 30 frames per second.

There are four MP3 decoders in each controller. They are simply labeled as 1 to 4. Before you can play a clip, you must tell the controller to prepare the clip to be played at a given decoder. The syntax is

Prepare <clip name> to <decoder number>;

Or

Prepare repeat <clip name> to <decoder number>;

<clip name> is the name of a clip or a variable of type *ClipVar* and <decoder number> is 1, 2, 3 or 4. The second form tells the decoder to prepare the clip to be played repeatedly. For example

Prepare myClip to 2;

will prepare myClip to be played by decoder 2. The *Prepare* command checks the *StartTime* and *StopTime* parameters of each clip and prepares the playback length accordingly.

There are 4 player control commands

CLStart <one or more decoder numbers separated by commas>;
CLStop <one or more decoder numbers separated by commas>;
CLPause <one or more decoder numbers separated by commas>;
CLResume <one or more decoder numbers separated by commas>;

Each command can be applied to one or more decoders simultaneously. For example,

CLStart 1;

will start decoder 1 playback and

CLStart 2,3,4;

will start decoders 2, 3 and 4 simultaneously. To wait for one or more decoders to finish the playback, use the *CLWait* command. For example,

CLWait 2,3,4;

will wait for all three decoders to finish their playback before proceeding to the next script statement. *CLStart* and *CLWait* can be combined as *CLStartW*.

CLStartW 2,3,4;

will start decoders 2, 3 and 4 and then wait for the decoders to finish playback.

There are 3 predefined variables for each decoder. *Playing1*, *Playing2*, *Playing3* and *Playing4* are readonly *Bit* variables indicating the state of the decoders, playing or stopped. These variables are TRUE even when the decoders are paused. They are FALSE only when the decoders are stopped. *PlayLength1*, *PlayLength2*, *PlayLength3* and *PlayLength4* are readonly *Long* variables reflecting the actual playback length set by the *Prepare* command. They are the same as the clip length if the entire MP3 file is to be played, otherwise, they are determined by the *StartTime* and *StopTime* clip parameters. *EndOfClip1*, *EndOfClip2*, *EndOfClip3* and *EndOfClip4* are readonly *Bit* variables. These variables have behavior similar to the *.up* and *.down* state of a *Bit* variable in the sense that they are being reset every time after you tested them. They are useful only when a decoder is prepared to playback in repeat mode. In repeat mode, the *PlayingX* variable would always be TRUE and you would not be able to tell when the clip is restarted. However, the *EndOfClipX* variable would be set to TRUE every time the clip reaches the end of the playback range. This is useful when we are trying to synchronize lighting cues or other events with the audio playing back in continuous loops.

As mentioned earlier, we can specify a variable of type *ClipVar* for the Prepare command. You can define a variable as *ClipVar* as follows.

```
ClipVar myClipVar;
```

You can assign a clip name to a *ClipVar* or assign another *ClipVar* to a *ClipVar*. For example,

```
myClipVar = myClip;
```

Once myClipVar is assigned with a clip, you can access all the clip parameters as if you are using the actual clip name. myClipVar.*len* is the same as myClip.*len*, etc. The only reason to introduce variables with type ClipVar is to allow the user to pick a clip randomly from a list and play the selected clip. The syntax to pick a random clip is

```
<clip var> = oneof (<clip name1>,<clip name2>,…,<clip nameN>);
```

For example,

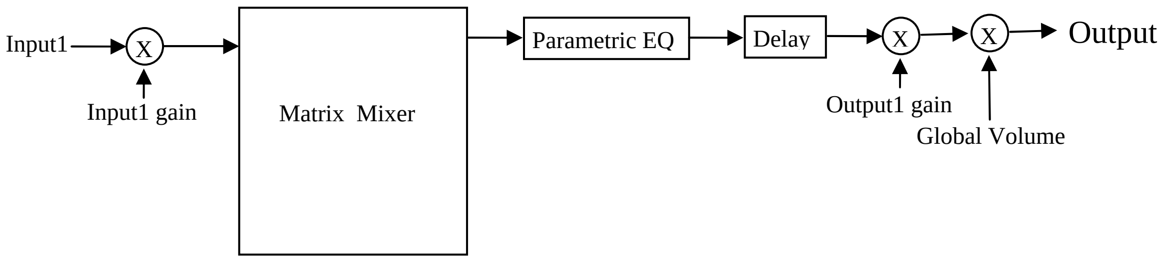
```
// define some clips here, myClip1, myClip2, myClip3
….
….
Cue myCue
{
        ClipVar myClipVar;                              // define a clip variable

        myClipVar = oneof(myClip1, myClip2, myClip3);   // pick one randomly
        // we are not guaranteed to always succeed since all the clips might still be
        // in Holdoff period. If no clip is selected, myClipVar would be set to 0.
        if (myClipVar != 0)
        {
                Prepare myClipVar to 2;                 // prepare to decoder 2
                ivolume3 = myClipVar.gain;              // set mixer input to
                                                        // clip specific gain
                ivolume4 = myClipVar.gain;              // assume stereo playback
```

```
                                                    // so need to set both channels
                ClStartW 2;                         // play till the end
            }
        }
```

J. Audio Mixer and Mixer Controls

Each 4MP3-MSC has a built-in digital audio mixer capable of audio panning in realtime. Panning and fading are initiated by script commands. The mixer engine is configured as



Only channel 1 is show, but all the input and output channels are configured identically. The MP3 decode 1 outputs are permanently mapped to Input1 and Input2, decoder 2 to Input3 and Input4, decoder 3 to Input5 and Input6 and decoder 4 to Input7 and Input8. The external stereo analog inputs are mapped to Input9 and Input10. The 8 inputs of the first ADAT channel are mapped to Input11 to Input18. The 8 inputs of the second ADAT channel are mapped to Input19 to Input26. Outputs 1 to 8 are mapped to the 8 analog outputs of the 4MP3-MSC. Outputs 9 to 16 are mapped to the 8 outputs of the first ADAT channel and outputs 17 to 24 are mapped to the outputs of the second ADAT channel. However, not all inputs and outputs are active. The number of active inputs and outputs are determined by the size of the Matrix Mixer. The default matrix size is 10 x 16. The matrix size can be changed in the script with the following command

MatrixSize = <number of inputs>,<number of outputs>;

For example,

MatrixSize = 10,18;   // size matrix size to 10 x 18

Whenever the matrix size is changed, the DSP core is reset. That means all the input and output volumes would be reset to unity (0.0 dB), output delays set to zero, all parametric EQ banks assigned with 1 Unity filter.
The input and output gains in dB are predefine script variables of type *Float*. The input gain variables are *iVolume1*, *iVolume2*, to *iVolume26* and the output gain

variables are *oVolume1*, *oVolume2* to *oVolume24*. Input gains and global volume cannot be more than unity, i.e., all *iVolumeX* and the *volume* variables must be less than or equal to zero in dB. However, the output gains can be as high as 12dB, i.e., all *oVolumeX* variables must be less than or equal to 12dB. The output delays are predefined script variables of type *Long*, *oDelay1* to *oDelay24*. The unit is in milliseconds. The maximum delay for each output is 225ms. Even though all these variables are predefined, only a subset defined by the size of the Mixer Matrix is active.

There are a total of 64 parametric EQ filters available for the entire mixer. They can be partitioned unevenly amongst the output channels. The minimum number of filter assigned to each output is 1. That means 1 filter must be assigned to an output even though that output does not require output equalization. The default number of filters assigned to each output is 1 and the default filter is a unity filter, i.e., the output of the filter is the same as the input. Use the NFilter command to partition the filters.

NFilter = 1,2,3,1,3,2;

The above command assigns 1 filter to output 1, 2 to output 2 and 3 to output 3, etc. The number of entries specified with the *NFilter* command must not exceed the number of active outputs. Repartitioning the filters would also initialize all the filters to unity filters.

Once the fitlers are partitioned, we can set the filter parameters with the *Filter* command. There are three different Filter command formats:

Filter(<which output>,<which filter>) = <filter type>,<filter frequency>;
Filter(<which output>,<which filter>) = <filter type>,<filter frequency>,<filter gain>;
Filter(<which output>,<which filter>) = <filter type>,<filter frequency>,<filter gain>,<filter bandwidth>;

<which output> specifies the mixer output number. <which filter> specifies which filter of the given output. <filter type> can be one of the 5 predefined constants *Lowpass*, *Highpass*, *Lowshelf*, *Highshelf* and *Bandpass*. <filter frequency> is an integer constant between 10 and 20000 and the unit is Hertz. <filter gain> is a floating point constant between -40.0 to 15.0 in dB. <filter bandwidth> is a floating point constant between 0.05 to 4.0 in octaves. A *Lowpass* or *Highpass* filter must be specified with the first form. A *Lowshelf* or *Highshelf* filter must be specified with the second form and the *Bandpass* with the third form. For example,

```
Filter(1,2) = Lowpass, 15000;          // Lowpass with 3dB frequency at 15kHz.
Filter(2,1) = Highshelf, 3000, 3.0;    // Highshelf at 3kHz and gain of 3dB.
Filter(3,1) = Bandpass,1000,-6.0,1.0;  // Bandpass at 1kHz, -6dB cut
                                       //    and bandwidth of 1 octave.
```

Any filter can be enabled or disabled with the follow commands

Filter(<which output>,<which filter>) = 1;   // enable filter
Filter(<which output>,<which filter>) = 0;   // disable filter

The cross-point multipliers of the mixer matrix can be changed with the *Fade* command. There are four such *Fade* commands.

Fade to Unity in <fade time expression>;
Fade to Zero in <fade time expression>;
Fade <input number> *to* <output gain list> *in* <fade time expression>;
Fade <input number> *to* <number> *of* <output gain list> *in*
    <fade time expression>;

The first form fades the diagonal elements of the matrix to unity, i.e. output 1 equals to input 1, output 2 equals to input 2, etc. All off diagonal cross-points are faded to zero, i.e., no contribution to the outputs. The second form fades all output to off. The <fade time expression> is an arithmetic expression evaluated to an integral number of frames representing the fade duration.

For the last two forms, <input number> must be an integer constant specifying the input number. <output gain list> is a list of the form

(<output number1>,<gain expression1>),
(<output number2>,<gain expression2>),…,
(<output numberN>,<gain expression>)

where <output numberX> must be an integer constant specifying the output number and <gain expressionX> is an arithmetic expression evaluated to a floating point value specifying the cross-point gain in dB. For the last form, <number> is an integer constant specifying how many entries of the <output gain list> to be picked randomly. For example,

Fade 2 *to* (1,-3.0),(2,-64.0) *in* 90;

would fade input 2 to output 1 to -3.0dB and to output 2 to -64.0dB in 3 seconds. A cross-point gain of -64.0dB is equivalent to turning off that cross-point.

Fade 2 *to* 2 *of* (1,-3.0),(2,-4.0),(3,-5.0),(4,-1.0) in fadeTime;

would fade input 2 to two of the 4 outputs in the list to the corresponding cross-point gain. The two outputs are picked randomly out of the 4 specified. The fade duration is stored in the variable fadeTime.

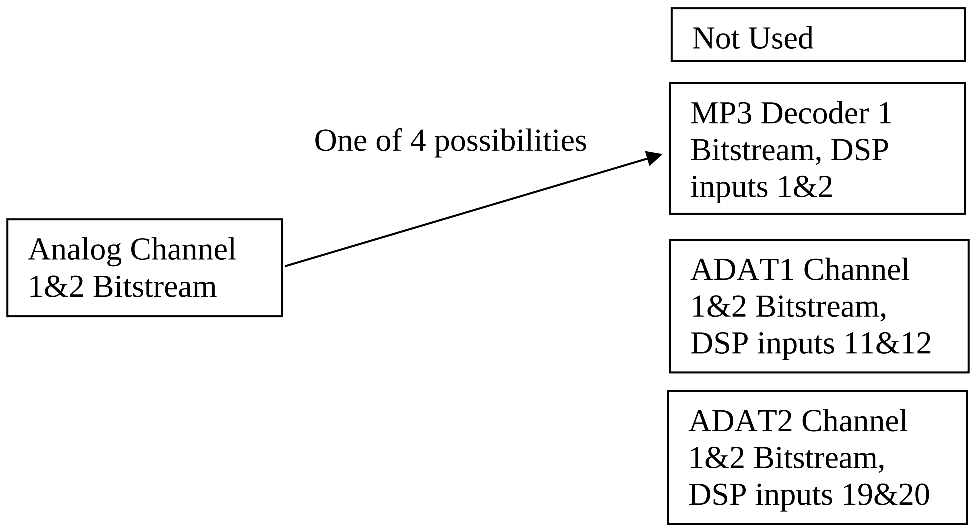
Fade 2 *to* (5, - *random*(3,6)) *in* 300;

would fade input 2 to output 5 in 10 seconds. The final cross-point gain is random between -3 to -6 dB.

> *Fade* 1 *to* (1,-64.0),(2,0.0) *in* 90;
> *Idle for* 90;
> *Fade* 1 *to* (2,-64.0),(3,0.0) *in* 90;
> *Idle for* 90;
> *Fade* 1 *to* (3,-64.0),(4,0.0) *in* 90;
> *Idle for* 90;

would pan input 1 from output 1 to output 2 in 3 seconds, then from output 2 to output 3 in 3 seoncds, and finally from output 3 to output 4 in 3 seconds.

Hardware with version 2.0 and above has 8 analog audio inputs added. However, we don't have enough resources to present another 8 inputs to the DSP. So a multiplexing scheme is created to remap inputs to the DSP. Because stereo ADCs are used, there are 4 bitstreams each carrying two channels of analog inputs. The multiplexing scheme is shown in the following figure:


Not Used
One of 4 possibilities
MP3 Decoder 1 Bitstream, DSP inputs 1&2
Analog Channel 1&2 Bitstream
ADAT1 Channel 1&2 Bitstream, DSP inputs 11&12
ADAT2 Channel 1&2 Bitstream, DSP inputs 19&20

Similarly, analog channel 3 & 4 bitstream can replace MP3 decoder 2 bitstream (DSP inputs 3 & 4), ADAT1 channel 3 & 4 bitstream (DSP inputs 13 & 14) or ADAT2 channel 3 & 4 bitstream (DSP inputs 21 & 22), etc. So we need two binary bits to represent each analog channel pair. Altogether we need 8 bits to select the 4 analog channel pairs. The selection is represented by a predefined global variable *AnalogAudioIn*. Bits 1 & 2 are for analog channel 1 & 2, bits 3 & 4 for channels 3 & 4, etc. When *AnalogAudioIn* is 0, no analog input is used. When *AnalogAudioIn* is 0x55, all the MP3 decoders are replaced with analog audio inputs and the analog inputs are at DSP inputs 1 to 8. When *AnalogAudioIn* is 0x5, then DSP inputs 1 to 4 are analog inputs 1 to 4, DSP inputs 5 to 8 are from the outputs of MP3 decoders 3 and 4.

K. Flow Control

Showgram has an extensive set of execution flow control commands. The simplest form is the *Jump* statement, which informs the cue engine to resume execution of the script at a statement with the given label. For example,

```
Jump gotIt;
```

where gotIt is a statement label. A statement label is a user-defined name starting at the beginning of a line followed by a colon. For example,

```
gotIt: cnt++;                // statement with the label gotIt.
```

The *While* statement allows execution of a simple or compound statement to be executed while a logical expression is evaluated to *True*. The syntax is

```
while (logical_expression)
        simple_or_compound_statement;
```

For example,

```
while (sensor && runAllowed)
{
        tally = !tally;                 // toggle tally
        idle for 30;                    // idle for a second
}
```

The above segment will blink the tally light at a rate of one second on followed by one second off while both sensor and runAllowed are *True*.

The *If* statement allows a simple or compound statement to be executed if a logical condition is evaluated to *True*. The *If-Else* combination statement allows an alternate statement to be executed if the condition is evaluated to *False*. For examples,

```
if (sensor && runAllowed)
{
        tally = True;                   // turn on the tally light
        myRelay = False;                // release the relay
}
if (addOne)
        count++;                        // if addOne is true, increment variable count
if (dogBarking)
{
        prepare dogClip to 1;           // prepare MP3 clip 1
        clstartw 1;                     // start playing and wait until done
}
else
```

```
{
        prepare catClip to 2;          // prepare MP3 clip 2
        clstart 2;                     // start but don’t wait, just preceed
}
```

In many occasions, we would like to execute different statements based on different values of an integer variable. One way to achieve this goal is with multiply nested *if-else* statements:

```
if (cnt == 1)
   Statement1;
else if (cnt == 3)
   Statement 2;
else if (cnt == 5)
   Statement3;
else if (cnt == 7)
   Statement4;
else
   Statement5;
```

The switch-case statement is a more elegant and more readable way to achieve the same goal:

```
switch (cnt)
{
case 1:
        statement1;
        break;
case 3:
        statement2;
        break;
case 5:
        statement3;
        break;
case 7:
        statement4;
        break;
default:
        Statement5;
        Break;
}
```

The simple *break* statement terminates the switch-case statement. If a *break* statement is not used at the end of a *case*, the statement in the next *case* will also be executed until a *break* is encountered or the last *case* has been reached. The *break* statement can also be used inside a *while* statement to break out of the *while* loop. When no case is matched, the statement in the *default* section would be executed. If no *default* section is defined, no statement would be executed.

The *for* statement allows execution of a simple or compound statement for a given number of time. The syntax is

```
For (initialize_statement; loop_condition; once_per_loop_statement)
        simple_or_compound_statement;
```

where initialize_statement is a simple statement to be executed at the beginning of the *for* statement block. loop_condition will be checked at the top of the *for* loop. If it is *True*, simple_or_compound_statement will be executed once. If it is *False*, the for loop terminates and the cue engine will move forward to the next statement. once_per_loop_statement is a simple statement that will be executed once after the simple_or_compound_statement has been executed. After its execution, the cue engine will check the loop_condition again and the loop continues. For example,

```
For (count = 1; count <= 10; count++)
{
   serialPort.Format("count = %ld"); // send "count = n" to the serial port, where
                                     // n is updated with the value of count
   idle for 30;                      // wait for a second
}
```

The above segment sends the strings "count = 1", "count = 2", …, "count = 10" to the serial port once a second. You may also use a *break* statement to get out of the *for* loop prematurely.

The *In* statement (4MP3-MSC Firmware V1.3 and above) allows a simple or compound statement to be executed over and over in a given period of time. The syntax is:

```
In (<integer expression>)
        Simple_or_compound_statement;
```

where <integer expression> will be evaluated to give an integer, specifying the duration of the execution period. For example,

```
In (300)
{
        if (sensor.down) jump gotIt;   // got sensor trigger, do something
}
// no sensor trigger, do something else
```

will wait for the sensor to be triggered, but no longer than 10 seconds (300 video frames).

The *On Halt Jump* statement allows cleaning up when a cue is told to halt. For example,

```
Cue myCue
{
        halt if (!MasterOn);            // halt if MasterOn is false
        on halt jump stopIt;            // if halted, jump to stopIt
        prepare myClip to 1;            // prepare clip 1
        clstartw 1;                     // start playback and wait
        exit;                           // exit the cue, normal exit here
stopIt:
        clstop 1;                       // stop the playback if halted
}
```

L. Remote Message Logging

Each 4MP3-MSC unit can send information to a PC host to be logged in a file. The PC must be running the 4MP3CON application. The 4MP3CON application creates a different log file for each day of the week and create different log files for different 4MP3-MSC units on the network. To enable logging, the IP address of the PC host must be specified with the *LogHostIP* command in the global scope, i.e., output any Cue. For example,

```
LogHostIP = 192.168.1.2;
```

Once the IP is specified, you may send logging information to the PC with the LogHost command inside any cue.

```
LogHost = “Movie started”;
LogHost = “Clip description is “ + myClipVar.dsc;
```

In addition to the log information sent from the script, the 4MP3-MSC itself sends a lot of other useful information regarding the state of the unit and starting/stopping of all clips being played. The amount of message can be throttled down by using the global property *Verbose:*

```
Verbose = TRUE;
```

The *Verbose* statement must be a global statement, i.e., outsize of any Cue body. When *Verbose* if *FALSE*, starting and stopping of cues won’t generate any log messages. *Verbose* is by default *FALSE* if not specified in the script.

For quick debugging, you can broadcast messages to all computers in the network running the 4MP3CON application with the *DEBUG* statement. The message would show up in the debug window at the bottom of the main 4MP3CON dialog. The debug message would also be added to the log file.

Debug = “Something happened here and now!”;

M. Keyboard Scanning

4MP3-MSC has built-in keyboard scanning using multiple digital inputs and digital outputs. On power up or loading of script, keyboard scanning is disabled. Use the *KeyScan* command to enable scanning.

KeyScan <nInputs>,<nOutputs>;

where <nInputs> is an integer between 2 and 8 and <nOutputs> is between 2 and 22. The sumof <nInputs> and <nOutputs> must not be greater than 24. The unit automatically allocates hardware resources starting with I/O pin1 for keyboard matrix input 1. The outputs are assigned immediately after the input pins. For example, if the matrix is 4x4, then I/O pins 1 to 4 are for matrix inputs and I/O pins 5 to 8 are for matrix outputs.

Once keyboard scanning is enabled, you may map *Bit* variables to the matrix cross-point.

```
Bit myButton1 = ScanNode(1,2);      // switch at input 1 and output 2
```

N. IR and Pseudo-Serial Transmission

All the digital outputs are capable of sending out IR signals or serial byte streams. The serial byte streams would follow the RS232 protocol except that the voltage level would not be strictly RS232. The send out IR signals, an IR file must be included in the script file. To include an IR file, use the preprocessor director #include

```
#include “aquos.inc”
```

The IR file consists of a series of #define statements, one for each IR code. Use the *FIRE* command to send an IR code to a digital output:

```
#include “aquos.inc”
Bit ir = dout2;                     // define a digital output bit variable

Cue myCue
{
        Fire AQUOS_POWER_ON to ir;
}
```

where AQUOS_POWER_ON is defined in the aquos.inc file. Although IR can be fired to all 24 digital outputs, there is only one IR engine in the system. That means only one IR output would be active at anytime. The sequencing of multiple firings issued at the same time is handled by the show controller. If multiple emitters must be fired with the same code simultaneously, the emitters must be electrically wired in parallel.

There are two ways to connect an IR emitter to the digital output. When a single IR emitter is used, the emitter can be connected between the digital output and lamp ground. When multiple emitters are connected in parallel, they must be connected between the digital output and lamp power with an appropriate current limiting resistor. The IR file must be created correctly for the two different wiring methods. So if you have multiple Aquos monitors, 3 wired together and 1 wired by itself between output and ground, two separate IR files must be created even though all the monitors are of the same type and the code name must be different.

The IR engine can also be used to fire pseudo RS232 serial byte streams to the digital outputs. “pseudo” in the sense that the voltage level is not strictly RS232 levels. But it works for most RS232 receivers. The connection is as simple as connecting the digital output and lamp ground to the remote RS232 RXD and GND wires. Only literal string constants can be sent out to the digital ports. The syntax is:

Ssend “my string” *to* myBitVar *at* myBaudrate;

where “my string” is a literal string, myBitVar is a digital output bit variable and myBaudrate is an integer constant specifying the baudrate. For example,

```
Bit pseudoSerial = dout2;

Cue myCue
{
        Ssend “hi there” to pseudoSerial at 9600;
}
```

O. Sending Email

You may send email messages directly from a script. This is useful for sending out warning or emergency messages to personnel overseeing the system. You must define all the necessary addresses before you can issue the send command. The sequences are:

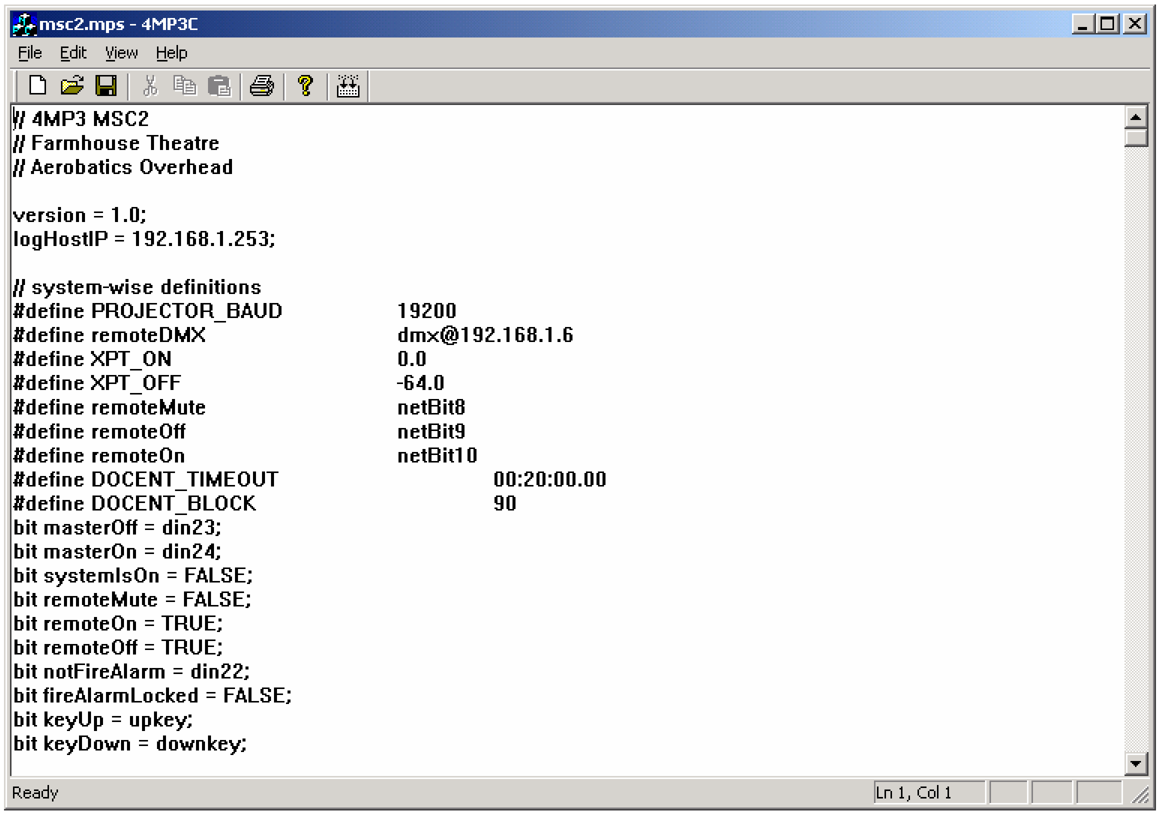
```
MailTo = “engineering@bbinet.com”;  // must have, can be string expression
MailFrom = “me@bbinet.com”;         // must have, can be string expression
MailSubject = “Testing email”;      // optional, can be string expression
MailHost = 12.34.56.78;             // must have and must be numeric IP
MailBody = “this is the message”;   // can be string expression
MailSend;                           // send it out
```

MailHost must be defined. It is the SMTP server that will actually send the email to the outside world. This host must be configured to allow email relaying from the show controller sending the email. Once you have defined the To and From address and the MailHost address, you may send multiple emails to the same address by changing MailBody and then execute MailSend. Since string constants cannot be longer than 255 characters, the mail body would be limited to 255 characters. MailTo, MailFrom, MailSubject, MailHost and MailBody are write only variables.

P. Showgram Compiler

Showgram script files are plain text files. They can be edited with the built-in editor of the compiler or any text editors or word processors that are capable of saving files in plain text format. Names of all Showgram script files must end with an extension of ".mps". Each script file must be compiled into a binary form for downloading.

The compiler program 4mp3c.exe is a 32-bit Microsoft Windows program. It has a built-in text editor very similar to the Windows' NotePad program. Figure 1 shows a running session of the compiler.



```
// 4MP3 MSC2
// Farmhouse Theatre
// Aerobatics Overhead

version = 1.0;
logHostIP = 192.168.1.253;

// system-wise definitions
#define PROJECTOR_BAUD          19200
#define remoteDMX               dmx@192.168.1.6
#define XPT_ON                  0.0
#define XPT_OFF                 -64.0
#define remoteMute              netBit8
#define remoteOff               netBit9
#define remoteOn                netBit10
#define DOCENT_TIMEOUT                      00:20:00.00
#define DOCENT_BLOCK                        90
bit masterOff = din23;
bit masterOn = din24;
bit systemIsOn = FALSE;
bit remoteMute = FALSE;
bit remoteOn = TRUE;
bit remoteOff = TRUE;
bit notFireAlarm = din22;
bit fireAlarmLocked = FALSE;
bit keyUp = upkey;
bit keyDown = downkey;
```

Figure 1. A running session of the 4MP3-MSC compiler.

The last button on the toolbar is the compile button. Or you may pull down the File menu to access the compile function. Once compiled, a warning and error screen will popup to show you the compilation result. If an error occurred, simply clicking the error line will send the cursor in the editor window to the offending line.

If myscript.ps is the input file, the compiler generates the following output files

myscript.ppf	- file generated by the pre-processor.
myscript.bin	- download binary file.
myscript.lst	- listing file generated only when the “-l” option is specified.
myscript.map	- map file generated only when the “-m” option is specified.

The pre-processor of the compiler looks for lines starting with “*#define*” and performs the corresponding macro substitutions. The pre-processed file is then compiled. The format of the “*#define*” macro is

#define macroName macroBody

where “macroName” is a string which is going to be substituted with the “macroBody”. For examples,

```
#define maxFrequency 12345
#define myName        “George W. Gore”
```

The pre-processor will look throughout the script file for the string “maxFrequency” and replaces it with the string “12345”. Similarly, “myName” will be substituted with “G.W. Gore”. Pre-processor “#define” macros are very useful for maintaining global parameters that can be adjusted at only one location inside the script file, instead of searching the file to perform multiple substitutions. Sometimes it is easier to look in the pre-processed file for errors embedded in the pre-processor macros. Pre-processor macros are cannot be recursive, i.e. you may not refer to a pre-processor macro inside the definition of another pre-processor macro.

Q. Command Reference

1. Cue Commands

a. *Absolute;*

Force the cue clock to be the same as the system clock.

b. *AutoStart;*

Cue with this command included in its body starts automatically when the 4MP3-MSC is powered up, immediately after a new script has been downloaded, or when the system is scheduled to start up.

c. *CStart* cueName*;*

CStart cueName1,cueName2,…,cueNameN;
The first form starts the cue with the name cueName. However, do not wait for cueName to finish. cueName can be a literal cue name or a variable of type *CueVar*. The second form starts the list of cues. cueNameX can be a literal cue name or a variable of type *CueVar*.

d. *CStartw* cueName;

   CStartw cueName1,cueName2,…,cueNameN;
   The first form starts the cue with the name cueName and wait till it has finished. cueName can be a literal cue name or a variable of type *CueVar*. The second form starts the list of cues and waits till all the cues stopped. cueNameX can be a literal cue name or a variable of type *CueVar*.

e. *CStop* cueName;

   CStop cueName1,cueName2,…,cueNameN;
   The first form stops the cue with the name cueName. cueName can be a literal cue name or a variable of type *CueVar*. The second form stops all the cues in the list. cueNameX can be a literal cue name or a variable of type *CueVar*.

f. *CWait* cueName;

   CWait cueName1,cueName2,…,cueNameN;
   The first form waits for the cue cueName to stop. cueName can be a literal cue name or a variable of type *CueVar*. The second form waits for all the cues in the list stopped. cueNameX can be a literal cue name or a variable of type *CueVar*.

g. *Enable If* <logical expression>;

   The cue engine evaluates the logical expression <logical expression> periodically. If the result is *True* and if the cue is not halted, not inhibited and not being held off, the cue will then start running. For example

```
Cue myCue
{
        Enable if (systemOn && button.Down);
        // other command statements
}
```

h. *Halt If* < logical expression>;

   If the cue is running, the cue engine evaluates the logical expression <logical expression> periodically. The cue will be halted if the result is *True*. For example,

```
Cue myCue
{
        Halt if (!systemOn || docentOn);
        // other command statements
}
```

i. *HoldOff* = <duration>;

   The parameter <duration> must be an integer constant in number of video frames (30 frames/sec). Once the cue has started execution, it would be prevented to start again for the subsequent <duration> frames. For example,

```
Cue myCue
{
        HoldOff 0:5:0.0;        // holdoff 5 minutes
        // other command statements
}
```

j. *Inhibit If* <logical expression>;

If the cue is not running, the cue engine evaluates the logical expression <logical expression> periodically. The cue will be prevented from starting as long as the result is True. For example,

```
Cue myCue
{
        Inhibit if (dogBarking);
        // other command statements
}
```

k. *On Halt Jump* jumpLabel;

If the cue is halted either by the *Halt If* expression, the *CStop* command or scheduled system stop, jump to the statement with label "jumpLabel". For example,

```
Cue myCue
{
        On Halt Jump cleanup;
        // other statements
        exit;                   // normal exit
cleanup:
        // do some cleanup here
}
```

l. *Relative;*

Set the cue clock to relative mode. In such mode, the cue clock will be reset to mid-night (zero) when the cue starts. All time references inside the cue will be relative to this cue start time. By default all cues are in relative mode unless the *Absolute* command is specified inside the cue body. For example,

```
Cue myCue
{
        Relative;
        // some statements
@0:0:1.0    nop;            // execute this 1 second after cue started
        // more statements
}
```

m. *Schedule* = *TRUE*; or *Schedule* = *FALSE*;

When the 7-day system-wise scheduling system is turned on, this command tells the cue engine that this cue is to follow the global schedule when *Schedule* is set to *TRUE*, or not when set to *FALSE*.

n. *StartTime* = op_hour_start;

o. *StopTime* = op_hour_stop;

op_hour_start and op_hour_stop are integer constants or SMPTE times. If op_hour_stop is larger than op_hour_start, the cue is allowed to run only if the system clock is between op_hour_start and op_hour_stop. If op_hour_stop is less than op_hour_start, the cue is allowed to run from mid-night to op_hour_stop and then from op_hour_start to mid-night. For example

```
Cue myCue
{
        StartTime = 7:0:0.0;        // allow to run from 7 am
        StopTime = 17:0:0.0;        // to 5 pm
        // more statements
}
```

2. Time Related Commands

a. *Elapsed();* or *Elapsed*(<integer expression>);

The first form returns the time elapsed since the cue started in number of video frames (30 frames/sec). The second form returns the time elapsed since the time specified by the value of the integer expression <integer expression>. For examples

```
lastTime = Now;                     // set lastTime to current time
// some statements here
myInt = Elapsed(lastTime);          // time spent executing those statements
```

b. *FrameSync;*

Wait idly until the system clock advances to the next video frame (30 frames/sec).

c. *Idle For* <integer expression>;

Wait idly for a duration equal to the result of the integer expression <integer expression>, in video frames (30 frames/sec).

d. *Idle for nextDay*;

Wait idly until just past midnight. This is useful when we are scheduling events to be run periodically and daily. Consider the following example:

```
Cue dailySchedule
```

```
{
        absolute;                          // use system clock
Loop:
*08:00:00.00   cstart ShowVideo;           // start show at 8am
*12:00:00.00 cstart ShowVideo;             // start show at 12pm
*16:00:00.00 cstart ShowVideo;             // start show at 4pm
        jump loop;                         // do it again next day
}
```

After starting the show at 4pm, the loop will be run continuously until midnight without starting the show again. After midnight, it would sit idly waiting for 8am. To prevent this continuous looping, we modify the cue to

```
Cue dailySchedule
{
        absolute;                          // use system clock
Loop:
*08:00:00.00   cstart ShowVideo;           // start show at 8am
*12:00:00.00 cstart ShowVideo;             // start show at 12pm
*16:00:00.00 cstart ShowVideo;             // start show at 4pm
        idle for nextDay;                  // wait till just beyond midnight
        jump loop;                         // do it again next day
}
```

After starting the show at 4pm, we would sit idly till just beyond midnight and then we loop back to the beginning and wait for 8am.

3. Loop/Flow Control Commands

a. *Break;*

Jump out of the current compound statement, except if the current compound statement is the main body of a cue. For examples,

```
while (doMore)
{
        if (getOut) break;                 // if getOut is true, break out of while
}
```

b. *Continue;*

Jump back to the beginning of the compound statement associated with a *While*, *For* or *In* loop. For example,

```
While (tmp > 0)
{
        if (tmp == 5) continue;            // back to beginning of loop
        // gets here if tmp is not equal to 5
        // more statements here
}
```

c. *Exit;*

Exit and stop a cue without running any *On Halt* statements. For example,

```
Cue myCue
{
        on halt jump recover;
        // some statements here
        exit;                          // exit the cue here
recover:
        // do halt recovery here
}
```

d. *For* Loop

The syntax of a *For* loop is

```
For (initialization_statement; loop_condition; pre_loopback_statement)
        Simple_or_compound_statement;
```

On entry of the *For* loop, the initialize_statement will be executed once. The loop_condition logical expression is then evaluated. If the condition is true, the Simple_or_compound_statement will be executed. The pre_loopback_statement is then executed before jumping back to check the loop_condition again. For example,

```
For (cnt = 0; cnt < 10; cnt++)
{
        tallyLight = True;
        idle for 30;
        tallyLight = False;
        idle for 30;
}
```

On entry of the above *For* statement, the variable cnt will be initialized to 0. cnt is then compared with 10. If cnt is less than 10, execute the 4 statements inside the pair of curly braces. cnt is then incremented. cnt is then compared with 10 again and the loop repeated until cnt is equal to 10.

e. *If and Else*

There are several forms of *If* and *else* statement. The simplest form is

```
If (logical_expression)
        Simple_or_compound_statement;
```

If the logical expression is evaluated to *True*, the Simple_or_compound_statement will be executed. For example,

```
If (masterOn && button.down)
    tmp = tmp + 1;
```

The next form is

```
If (logical_expression)
        Simple_or_compound_statement;
else
        another_simple_or_compound_statement;
```

In this case, the another_simple_or_compound_statement will be executed instead if the logical_expression is *False.*

The final form is a multiple nesting of the *If-else* statement

```
If (logical_expression1)
        Simple_or_compound_statement1;
else if (logical_expression2)
        Simple_or_compound_statement2;
else if (logical_expression3)
        Simple_or_compound_statement3;
        ….
```

f. *In*

The syntax of the *In* statement is

```
In (<integer expression>)
        Simple_or_compound_statement;
```

On entry of the *In* statement, the integer expression is evaluated. The Simple_or_compound_statement is then executed repeatedly for a number of video frames (30 frames /sec) equal to the value of the integer expression. For example,

```
In (300)
{
        tmp++;
        if (button.down) break;  // if we get a button push, exit this loop
                                 // otherwise, this loop will be run for 10 seconds
}
```

g. *Jump/Goto* Label;

   Do an unconditional jump to the given label. For example,

h. *Switch, Case* and *Default*

   The syntax is

```
Switch (<integer expression>)
{
case integer_value1:
        simple_or_compound_statement1;
        break;
case integer_value2:
        simple_or_compound_statement2;
        break;
// more cases here
case integer_valueN:
        simple_or_compound_statementN;
        break;
default:
        simple_or_compound_default_statement;
}
```

   On entry, the <integer expression> is evaluated. The result is then compared with integer_value1, integer_value2, …, integer_valueN. If the result is equal to integer_valueK, say, then simple_or_compound_statementK will be executed. If it does not match any of the case integers, simple_or_compound_default_statement will be executed. If no *default* case is specified, the cue engine will proceed to the next statement. If a *break* statement is not included at the end of the case statement, then the next case statement will also be executed. For example,

```
Switch (tmp*2+1)
{
case 1:
        result = 1;
        break;
case 5:
        result = 5;
case 9:
        result = 9;
        break;
default:
        result = 11;
}
```

If tmp has a value of 0, then result will be 1. If tmp has a value of 2, the result will not be 5, but 9 since the *break* statement is missing after the line “result = 5;”. If tmp is not 0, 2 nor 4, then the result will be 11.

i. *While*

The syntax is

```
While (logical_condition)
        Simple_or_compound_statement;
```

The Simple_or_compound_statement will be executed repeatedly while the logical_condition is *True*. For example,

```
While (!button.Down)
{
        // do something here
        tmp++;
}
```

4. String/Serial Port/Pioneer Player Commands

a. *AtoI*(<string expression>)

Scan the result of the string expression until it encounters the first non-digit chararacter and return the corresponding integer value of the string. For example,

```
myInt = AtoI(“124abc”);      // myInt will be set to 124
myInt = AtoI(“abc124”);      // myInt will be zero since the first character is not a
digit
```

b. *AtoF*(<string expression>)

Scan the result of the string expression until it encounters the first character not being one of “0123456789,+-eE” and return the corresponding floating-point value of the string. For example,

```
myFlt = AtoF(“124abc”);      // myFlt will be set to 124.0
myFlt = AtoF(“-3.456apples”); // myFlt will be set to –3.456
```

c. *.Baud*

This is a write-only member property of a serial-port-mapped string variable. It assigns an integer value to set the baud rate of the corresponding serial port. The supported baud rates are 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200. The default rate is 9600 for port 1 and 2, and 115200 port3 (the host port). Changing the baud rate also causes the serial port hardware to be reinitialized and the transmit and receive buffers emptied. For example,

```
String pc = port1;
pc.baud = 9600;                    // set port 1 serial baud rate to 9600
```

d. *.Block*

This is a read-only member property of a serial-port-mapped string variable with the serial port connected to a Pioneer laser disc player. It returns the current block number of the player. For example,

```
String discPlayer = port1;
If (discPlayer.Block != 1)
{
        // do something
}
```

e. *.Chapter*

This is a read-only member property of a serial-port-mapped string variable with the serial port connected to a Pioneer DVD player. It returns the current chapter being played or after seeking. For example,

```
String discPlayer = port1;
If (discPlayer.Chapter != 2)
{
        vsearchw discPlayer to “CH2”;         // search to Chapter 2
}
```

f. *.CSize*

This is a write-only member property of a serial-port-mapped string variable. It is used to specify the number of bits in each transmitted character. The supported values are 5, 6, 7 and 8 for port 1 and 2, and 8 only for port 3. The default is 8. For example,

```
String discPlayer = port1;
DiscPlayer.CSize = 8;
```

g. *.Empy() or .Empty(<integer expression>)*

This is a member function of a serial-port-mapped string variable. The first form without an argument empties the entire serial port receive buffer. The second form removes a number of characters equal to the result of <integer expression>. For example,

```
String discPlayer = port1;
discPlayer.Empty(5);                    // empty 5 characters from port
```

h. *.Frame*

This is a read-only member property of a serial-port-mapped string variable with the serial port connected to a Pioneer laser disc or DVD player. It returns the current video frame location being played or after seeking. For example,

```
String discPlayer = port1;
If (discPlayer.Frame != 1000)
{
        vsearchw discPlayer to "FR1000";    // search to frame 1000
}
```

i. *.Find*(string_expression)

This is a member function of a *String* variable. It evaluates the string_expression and searches the String variable for the resulting string. If the string cannot be found, it returns 0. If it is found, it returns the starting index where the string is. For example,

```
myStr = "abcdefg";
myInt = myStr.Find("ijk");            // not found, myInt will be zero
myInt = myStr.Find("cde");            // found at position 3, myInt will be 3
```

j. *Fmt*(fmt_string, variable)

The format function behaves like sprintf in C. It uses the format string fmt_string and the variable to form a string. It differs from sprintf is that it only allows one variable at a time. However, the full sprintf capabilities can be achieved with concatenation of multiple *Fmt* function calls. For details about the available format options, please consult a C language reference. For example,

```
myInt = 123;
myStr = fmt("Result = %ld bytes", myInt);  // myStr = "Result = 123 bytes"
```

The long integer format string %ld is used here since all integer variables in Showgram are treated as long integer variable in the 4MP3-MSC firmware.

k. *.Format*(fmt_string, variable)

This is the same as the Fmt function except that it is in a member function of a *String* variable. The result of the format function will be stored in the *String* variable. So an alternate form of the last example statement is

```
myStr.Format("Result = %ld bytes", myInt);
```

l. *Hold*(port_string_variable1,…, port_string_variableN);

Put on hold the transmission of the serial ports corresponding to the list of serial-port-mapped string variables. For example,

```
String p1 = port1;
String p2 = port2;
Hold(p1, p2);                    // put port1 and port2 transmission on hold
```

m. *.Len*

This is a member property of a *String* variable. It returns the number of characters stored in the parent string. For example,

```
myStr = “abcde”;
myInt = myStr.len;               // myInt would be 5
```

n. *.Parity*

This is a write-only member property of a serial-port-mapped string variable. It is used to specify the port parity. The supported values are *None*, *Odd*, *even*, *Mark* and *Space* for port 1 and 2, but *None* only for port3. The default is *None*. For example,

```
String p1 = port1;
P1.parity = Odd;
```

o. *Release*(port_string_variable1,…, port_string_variableN);

Release and allow transmission of the serial ports corresponding to the list of serial-port-mapped string variables. For example,

```
String p1 = port1;
String p2 = port2;
Release(p1, p2);                 // put port1 and port2 transmission on hold
```

p. *.Reset()*

This is a member function of a serial-port-mapped *String* variable. It resets the serial corresponding serial port: resetting the serial hardware and emptying both the receive and transmit buffers. For example,

```
String p1 = port1;
p1.Reset();
```

q. *.SetMSB*

This is a member property of a serial-port-mapped *String* variable. When set to *TRUE*, all bytes sent out of the serial port would have the most significant bit set to 1.

r. *.Stopbit*

This is a write-only member property of a serial-port-mapped string variable. It is used to specify the number of stop bit to be included in each transmitted character. The supported values are 1 and 2 for port 1 and 2, and 1 only for port 3. The default is 1. For example,

String p1 = *port1*;
p1.*Stopbit* = 1;

s. .*SubStr*(start_<integer expression>, stop_<integer expression>)

This is a member function of a *String* variable. It extracts a sub-string out of the *String* variable. The first argument is evaluated to give the starting index of the sub-string and the second argument gives the ending index. For example,

```
String tstr;
String p1 = “abcdef”;
tstr = p1.SubStr(2,5);          // tstr set to “bcdef”
```

t. .*Terminator*

This write-only member property of a serial-port-mapped String variable sets the termination character of the corresponding serial port. String length calculations and string references are all based on having the termination character as the last character of a string/sentence. For example,

```
String p1 = port1;
p1.Terminator = ‘.’;            // set the termination character to ‘.’.
```

u. .*Time*

This is a read-only member property of a serial-port-mapped string variable with the serial port connected to a Pioneer laser disc or DVD player. It returns the track time of the current play location during a playback or after seeking. For example,

```
String discPlayer = port1;
If (discPlayer.time != 1234)
{
        vsearchw discPlayer to “TM1234”;   // search to time 12:34
}
```

v. .*Track*

This is a read-only member property of a serial-port-mapped string variable with the serial port connected to a Pioneer laser disc player. It returns the current track being played or after seeking. For example,

```
String discPlayer = port1;
If (discPlayer.Track != 2)
{
        vsearchw discPlayer to “TR2”;      // search to Chapter 2
}
```

w. *.Type*

This write-only member property of a serial-port-mapped *String* variable sets the serial port type. The currently supported types are *ASCII* and *LD*. The *ASCII* type is for generic message passing via the serial port. On the other hand, ports with type *LD* can be controlled with the dedicated video player functions. For example,

```
String discPlayer = port1;
discPlayer.type  = LD;
```

x. *VPause* port_string_variable; or *Vpausew* port_string_variable;

port_string_variable is a serial-port-mapped *String* variable with the serial port connected to a Pioneer laser disc or DVD player. If the player is playing, this command pauses the player and also blank the video output. The *VPausew* form would not return control to the cue engine until the player has acknowledged reception of the command. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// spin up the player and start the play etc here
VPause discPlayer;
```

y. *.VPause* and *.VPausew*

.VPause and *.VPausew* are member function of a serial-port-mapped *String* variable with the serial port connected to a Pioneer laser disc or DVD player. If the player is playing, this command pauses the player and also blank the video output. The *.VPausew* form would not return control to the cue engine until the player has acknowledged reception of the command. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// spin up the player and start the play etc here
discPlayer.VPausew();
```

z. *Vplay* port_string_variable; or *Vplayw* port_string_variable;

port_string_variable is a serial-port-mapped *String* variable with the serial port connected to a Pioneer laser disc or DVD player. This command starts the playback. The *VPlayw* form would not return control to the cue engine until the player has acknowledged reception of the command. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// spin up the player here
VPlayw discPlayer;
```

aa. *.Vplay* and *.Vplayw*

.VPlay and *.VPlayw* are member function of a serial-port-mapped *String* variable with the serial port connected to a Pioneer laser disc or DVD player. This command starts the playback. The *.VPlayw* form would not return control to the cue engine until the player has acknowledged reception of the command. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// spin up the player here
discPlayer.VPlayw();
```

bb. *VSearch and VSearchw*

There are two variations of each of these commands. The four forms are

```
VSearch port_string_variable to <integer expression>
VSearch port_string_variable to string_expression
VSearchw port_string_variable to <integer expression>
VSearchw port_string variable to string_expression
```

Port_string_variable is a serial-port-mapped String variable with the serial port connected to a Pioneer laser disc or DVD player. This commands inform the player to advance its play head to the specified location. The <integer expression> is evaluated to give a destination assuming the currently active search mode (frame, track, index, chapter, block etc). The string_expression is evaluated to give a destination with optional search mode included in the string. The VSearchw form would not return control to the cue engine until the player has acknowledged reception of the command. This usually also means waiting till the search is over. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// spin up the player here
VSearchw discPlayer to 1234;          // using default search mode
VSearchw discPlayer to “FR1234”       // search to frame 1234
VSearchw discPlayer to “TM1234”       // search to time location 12:34
```

cc. *.VSearch* and *.VSearchw*

There are two variables of each of these two member functions of a serial-port-mapped *String* variable. The four forms are

```
port_string_variable.VSearch(<integer expression>);
port_string_variable.VSearch(string_expression);
```

port_string_variable.*VSearchw*(<integer expression>);
port_string_variable.*VSearchw*(string_expression);

This commands inform the player to advance its play head to the specified location. The <integer expression> is evaluated to give a destination assuming the currently active search mode (frame, track, index, chapter, block etc). The string_expression is evaluated to give a destination with optional search mode included in the string. The .VSearchw form would not return control to the cue engine until the player has acknowledged reception of the command. This usually also means waiting till the search is over. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// spin up the player here
discPlayer.VSearchw(1234);            // using default search mode
discPlayer.VSearchw("FR1234");        // search to frame 1234
discPlayer.VSearchw( "TM1234");       // search to time location 12:34
```

dd. *VSend* cmdString *To* port_string_variable; or *VSendw* cmdString *To* port_string_variable;

port_string_variable is a serial-port-mapped *String* variable with the serial port connected to a Pioneer laser disc or DVD player. You may send a generic string 'cmdString' to the Pioneer laser disc or DVD player with this command. This is useful when you need to control the player with player specific commands that are not provided by other video relayed Showgram commands. You don't need to include the command termination character <CR>. The *VSendw* form would not return control to the cue engine until the player has acknowledged reception of the command. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// set the stop marker to 1234 and then play
VSend "1234SM PL" To discPlayer;
```

ee. .*VSend* or .*VSendw*

.*VSend* is a member function of a serial-port-mapped *String* variable. You may send a generic string to the Pioneer laser disc or DVD player with this member function. This is useful when you need to control the player with player specific commands that are not provided by other video relayed Showgram commands. You don't need to include the command termination character <CR>. The .*VSendw* form would not return control to the cue engine until the player has acknowledged reception of the command. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
```

```
// set the stop marker to 1234 and then play
discPlayer.VSend("1234SM PL");
```

ff. *VStill* port_string_variable; or *VStillw* port_string_variable;

port_string_variable is a serial-port-mapped *String* variable with the serial port connected to a Pioneer laser disc or DVD player. If the player is playing, this command pauses the player but leaves the last video frame on the video output. The *VStillw* form would not return control to the cue engine until the player has acknowledged reception of the command. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// spin up the player and start the play etc here
VStillw discPlayer;
```

gg. .*VStill* and .*Vstillw*

.*VStill* and .*VStillw* are member function of a serial-port-mapped *String* variable with the serial port connected to a Pioneer laser disc or DVD player. If the player is playing, this command pauses the player and also blank the video output. The .*VStillw* form would not return control to the cue engine until the player has acknowledged reception of the command. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// spin up the player and start the play etc here
discPlayer.VStill();
```

hh. *VStop* port_string_variable; or *VStopw* por_string_variable;

port_string_variable is a serial-port-mapped *String* variable with the serial port connected to a Pioneer laser disc or DVD player. This command stops and spins down the player. The *VStopw* form would not return control to the cue engine until the player has acknowledged reception of the command. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// spin up the player and start the play etc here
VStopw discPlayer;
```

ii. .*VStop* and .*VStopw*

.*VStop* and .*VStopw* are member function of a serial-port-mapped *String* variable with the serial port connected to a Pioneer laser disc or DVD player. This command stops and spins down the player. The .*VStopw* form would not return control to the cue engine until the player has acknowledged reception of the command. For example,

```
String discPlayer = port1;
discPlayer.type = LD;
// spin up the player and start the play etc here
discPlayer.VStopw();
```

5. MP3 Playback Commands

a. *ClStart* <comma separated decoder list>

ClStartw <comma separated decoder list>
Start the playback of a previously prepared MP3 clips. The *ClStartw* form starts the playback and waits till the playback is over. The <comma separated decoder list> is one or more decoder number separated by commas. For example,

```
ClStartw1,3;                // start decoders 1 & 3 and wait till both
                            // both decoders have finished.
```

b. *ClStop* <comma separated decoder list>;

Force an immediate stop of the MP3 playback. For example,

```
ClStop1,3;                  // stop decoders 1 & 3
```

c. *ClWait* <comma separated decoder list>;

Wait idly until the MP3 playback is over. For example,

```
ClWait 1,3;                 // wait till decoder 1 & 3 finished
```

d. *ClResume* <comma separated decoder list>;

Resume playback at the specified decoders. For example,

```
ClResume 1,3;               // resume playback at decoder 1 & 3
```

e. *ClPause* <comma separated decoder list>;

Pause the specified decoders. For example,

```
ClPause 1,3;                // pause decoder 1 & 3
```

f. *Prepare*

Prepare a MP3 clip for playback. There are 2 forms of this command:

```
Prepare <clip name or clip var> to <decoder number>;
Prepare repeat <clip name or clip var> to <decoder number>;
```

<clip name or clip var> is either a literal clip name defined earlier or a variable of type *ClipVar*. The second form will prepare the clip to be played repeatedly.

```
Prepare myClip to 2;            // prepare clip myClip to play at decoder 2
Prepare repeat myClipVar to 2; // prepare clip assigned to the myClipVar
                                // ClipVar variable to be played at decoder 2
                                // and loop repeatedly.
```

6. Digital Mixer Related Commands

a. *MatrixSize* <nInputs>,<nOutputs>;
Sets the size of the mixer matrix. <nInputs> must be between 8 and 18 and <nOutputs> must be between 8 and 24. When this command is issued, the DSP core is reinitialized. That means the filter banks need to be repartitioned, filter parameters, input volumes, output volumes and output delays need to be set again. For example,

```
MatrixSize 10,16;       // 10 inputs and 16 outputs
```

b. *NFilter*   <nFilter1>,<nFilter2>,…,<nFilterN>;
Distribute the 64 available parametric EQ filters amongst the output filter banks. The parameter list must not be longer than number of outputs defined for the mixer matrix. If the number of parameters is less than the number of outputs defined for the mixer matrix, then the unspecified outputs are set to have 1 unity filter in their filter bank. The sum of parameter list also should not exceed 64. After repartitioning, all the filters would be initialized to unity filters. For example,

```
NFilter 2,3,2,2,2;
```

c. *Filter*(<which output>,<which filter>) = 1;
Fitler(<which output>,<which filter>) = 0;
The first form enable filter <which filter> of output <which output>. For example,

```
Filter(2,2) = 0;                    // disable filter 2 or output 2
```

d. *Filter*(<which output>,<which filter>) = *Highpass*,<filter frequency>;
Filter(<which output>,<which filter>) = Low*pass*,<filter frequency>;
The first form defines a highpass filter at the specified filter frequency and the second form defines a lowpass filter. <filter frequency> must be an integer between 20 and 20000Hz. For example,

```
Filter(1,2) = Lowpass,4000;         // lowpass at 4kHz.
```

e. *Filter*(<which output>,<which filter>) = Highshelf,<filter frequency>,<filter gain>;
Filter(<which output>,<which filter>) = Lowshelf,<filter frequency>,<filter gain>;
The first form defines a high shelf filter at the specified frequency and the specified gain. <filter frequency> must be an integer between 20 and 20000Hz. <fitler gain> must be between -40.0 and 15.0 in dB. For example,

```
Filter(1,2) = Highshelf,4000,3.0;      // highshelf at 4kHz with 3dB gain
```

f. *Filter*(<which output>,<which filter>) = Bandpass,<filter frequency>,<filter gain>,<filter bandwidth>;
Defines a bandpass filter. <filter frequency> must be an integer between 20 and 20000Hz. <filter gain> must be between -40.0 and 15.0 dB. <filter bandwidth> must be between 0.05 and 4.0 in octaves. For example,

```
Filter(1,2) = Bandpass,1000,-6.0,1.2;        // bandpass at 1kHz,
                                             // -6dB gain and
                                             // 1.2 octave wide.
```

g. *Fade to Unity in* <fade time expression>;

Fade the mixer matrix to a unity matrix in the given fade time. <fade time expression> is an arithmetic expression to be evaluated to an integral number of frames assuming 30 frames per second. For examples,

```
Fade to Unity in 30;            // fade to unity matrix in 1 second
Fade to Unity in (30 + random(60,120));     // fade to unity matrix
                                // fade time is between 3 to 5 seconds
```

h. *Fade to Zero in* <fade time expression>;

Fade all mixer matrix to a zero matrix, i.e. all off, in the given fade time. <fade time expression> is an arithmetic expression to be evaluated to an integral number of frames assuming 30 frames per second. For example,

```
Fade to Zero in 90;             // everything off in 3 seconds
```

i. *Fade* <input number> *to* <output gain list> *in* <fade time expression>;

Fade the given input to the list of outputs at the given gain. <output gain list> is one or more of (<output number>,<gain expression>) separated by commas. <output number> specifies the output and <gain expression> is an arithmetic expression to be evaluated to a floating point number representing the cross-point gain in dB. The cross-point gain must be less than or equal to zero dB. <fade time expression> is an arithmetic expression to be evaluated to an integral number of frames assuming 30 frames per second. For example,

```
Fade 2 to (1,0.0),(2,-64.0) in 90;     // fade input 2 to output 1 full
```

```
                                   // and input 2 to output 2 off
                                   // in 3 seconds
```

j. *Fade* <input number> *to* <number> *of* <output gain list> *in* <fade time expression>

Fade the given input to some of the list of outputs at the given gain. <number> is the number of outputs to be picked randomly from the list. <output gain list> is one or more of (<output number>,<gain expression>) separated by commas. <output number> specifies the output and <gain expression> is an arithmetic expression to be evaluated to a floating point number representing the cross-point gain in dB. The cross-point gain must be less than or equal to zero dB. <fade time expression> is an arithmetic expression to be evaluated to an integral number of frames assuming 30 frames per second. For example,

```
Fade 2 to 1 of (1,0.0),(2,0.0) in 90;   // fade input 2 to either output 1
                                        // or output 2 in 3 seconds. The
                                        // chance of picking one or the other
                                        // is 50-50.
```

7. Digital I/O Related Commands

a. *.Count*

This is a member property of *Bit* variables mapped to *Din1*, *Din3, Din5, Din7, Din9 and Din11*. In addition to the standard logical True/False (logical high/low), there are six digital counters, attached to *Din1*, *Din3, Din5, Din7, Din9 and Din11*. These counters are incremented everytime there is a low to high transition at the input. The *.Count* member property returns an integer value corresponding to the current counter value. Everytime this member property is referenced, the hardware reset the counter to 0. There are two counter modes, *Linear* and *Quadrature*. Linear counting only involves one digital input, *Din1*, *Din3, Din5, Din7, Din9 and Din11*. Quadrature counting involves two digital inputs, *Din1* and *Din2* for one counter and *Din3* and *Din4* for counter 2, etc. However, the counter values are still accessed via *Din1* and *Din3*. For example,

```
Bit in1 = Din1;
Bit in3 = Din3;
in1.type = Linear;             // set it to linear mode
in2.type = Quadrature;         // set it to quadrature mode
myInt1 = in1.Count;            // get linear counter value
myInt2 = in2.Count;            // get quadrature counter value
```

b. *.DutyCycle*

This is a member property of a *Bit* variable mapped to a digital output configured to generate a PWM (Pulse Width Modulated) signal. This member property specifies the percentage of the period that the output will be in a logical high state. For example,

```
Bit out2 = Dout2;
out2.Type = PWM;
out2.DutyCycle = 50;            // set to 50% duty cycle
```

c. *.io*

This is a member property of a *Bit* variable mapped to a digital output. When declared TRUE, the given digital output can also be used as a digital input simultaneously. The output driver will be turned off momentarily periodically so that the input state of the pin can be sampled. This option is turned off by default.

d. *.Type*

This is a member property of a *Bit* variable mapped to a digital input or output. This member property does nothing for *Din2*, *Din4* to*Din14*. For *Din1* and *Din3*, please refer to the *.Count* member property in above. All 4MP3-MSC digital outputs can be configured to generate PWM (Pulse Width Modulation) outputs. The PWM base frequency is set by the predefined system variable *PWMFreq*. The duty cycle is set by the *.DutyCycle* member property in above. The two allowable modes are *Normal* and *PWM*. By default, all digital outputs are in *Normal* mode. For example,

```
Bit out2 = Dout2;               // map a Bit variable to Dout2
out2.type = PWM;                // change to PWM mode;
```

8. LCD Display Commands

The LCD display is an optional hardware for the 4MP3-MSC controller. The display has 2 lines of 20 characters each.

a. *.Display*

This is a member function of all *Bit*, *Int, Float* and *String* variables. There are two forms

```
.Display(line_<integer expression>);
.Display(line_<integer expression>, column_<integer expression>);
```

The line_<integer expression> is evaluated to give which line of the display to be used. The column_<integer expression> is evaluated to give the starting column within the selected line. The value of line_<integer expression> must be 1 or 2. The value of column_<integer expression> must be between 1 and 20. For *Bit*, *Integer* and *Float* variables, the 4MP3-MSC uses its own default to format the output. If you want specific output format, please use the *.Format* member function or the *Fmt* function. For examples,

```
myInt.Display(1);              // display to line 1
myInt.Display(2, 10);          // display to line 2 starting at column 10
```

b. *Display*

This is an alternate form of the *.Display* member function. The possible forms are

> *Display* variable *to* line_<integer expression>;
> *Display* variable *to* line_<integer expression> *at* column_<integer expression>;

For examples,

> *Display* myInt *to line1*;   // *line1* and *line2* are predefined constant
> *Display* myFloat *to line2 at* 10; // display to line 2 starting at column 10

9. Miscellaneous Commands

a. *Version* = <version number>;

You may define a version number for the script file with the Version command. It must be defined in the global scope, i.e., not inside any cue. <version number> can be any integer or floating point constants. For example,

> *Version* = 3.4;   // script version 3.4.

b. *hwVersion* = <version number>;

You must specify the hardware version to match hardware being used. Some script capabilities were added as the hardware evolved. Hardware with older version won't be able to execute these commands. By knowing the *hwVersion*, the compiler would warn you if you try to use features that are incompatible with the hardware.

c. *Verbose* = *TRUE* or *Verbose* = *FALSE*

Like Version, *Verbose* is set to *TRUE* or *FALSE* in the compiled script and cannot be changed in real time with cue statements. By default *Verbose* is *FALSE*. If *Verbose* is false, the controller won't generate log messages when a cue starts or stops.

d. *Nop*

This command does nothing. It is usually used as a placeholder for time-stamping or labeling. For example

```
@0:1:0.0       Nop;
loop:          Nop;
```

e. *DMX* = “<DMX command>”;

Send the DMX command to the DMX fade engine. See the DMX section for the command syntax. For example,

DMX = “C1-10@40F90”; // channel 1 to 10 to 40% in 3 seconds

f. *DMX*@<IP Address> = “<DMX command>”;

Send a DMX command to the DMX fade engine of the 4MP3-MSC with the given IP address. For example,

DMX@192.168.1.2 = “C1-10@40F90”;

g. *UDP*@<IP Address>,<UDP Port> = “<UDP packet>”;

Send a UDP packet to the given UDP port of the machine with the given IP address. This is a generic UDP packet and so the recipient does not need to be a 4MP3-MSC. For example,

UDP@192.168.1.2,10002 = “C1-10@40F90”;

Sends the DMX command to port 10002 of the machine with IP address 192.168.1.2.

h. *LogHostIP* = <IP Address>;

Tell the 4MP3-MSC unit that all logging information should be sent to the machine with the given IP address. For example,

LogHostIP = 192.168.1.2;

i. *LogHost* = “<Message to be logged>”;

Send the log message to the log host. For example,

LogHost = “Show started”;

j. Mathematical functions - *Sin(x), ASin(x), Cos(x), ACos(x), Tan(x), ATan(x), Sqrt(x), Exp(x), Log(x), Log10(x), Pow10(x)*

All these functions take a *Float* argument and return a *Float* value.

k. *Random*(max_<integer expression>); or *Random*(min_<integer expression>, max_<integer expression>);

This functions return a random integer value. min_<integer expression> will be evaluated to give the lower bound of the range of values the random number will fall within. max_<integer expression> gives the upper bound of the range. The first form with a single argument assumes that the lower bound is always 1. For example,

myInt = *Random*(100); // random number between 1 and 100 myInt = *Random*(50,100);   // random number between 50 and 100

R. Predefined System Variables and Constants

1. **Adc1, Adc2, Adc3, Adc4 –** analog input at the analog DB9

   These are readonly *Long* variables. They have a range of 0 to 4096. With 4096 corresponding to full scale 5 volts at the ADC input. They are also network accessable.

2. ***adat1Loopback*, *adat2Loopback* –** loop ADAT input back to output

   These are readable and writable *Bit* variables. If set to TRUE, the ADAT inputs are looped back to the ADAT outputs. These are useful when we are trying to pipe the MP3 outputs from one unit to another unit with minimum delay.

3. ***adatSource* –** select audio source for each of the 8 ADAT stereo pairs

   This is a readable and writable *Long* variable. However, only the bottom eight bits have meaning. Bit 0 controls ADAT1 outputs 1 and 2, bit 1 for ADAT1 outputs 3 and 4, bit 2 for ADAT1 outputs 5 and 6, bit 3 for ADAT1 outputs 7 and 8, bit 4 for ADAT2 outputs 1 and 2, bit 5 for ADAT2 outputs 3 and 4, bit 6 for ADAT2 outputs 5 and 6 and bit 7 for ADAT2 outputs 7 and 8. When a bit is 1, the outputs from the mixer matrix outputs are selected. When the bit is 0, the outputs from the MP3 decoder are selected. Bit 0 and bit 4 will select mixer outputs 1 and 2 or decoder 1, bit 1 and bit 5 will select mixer outputs 3 and 4 or decoder 2, bit 2 and bit 6 will select mixer outputs 5 and 6 or decoder 3, and bit 3 and bit 7 will select mixer outputs 7 and 8 or decoder 4.

4. ***analogAudioIn* –** analog input multiplexing

   Each two bits of the bottom 8 bits of this variable define how a analog channel pair is mapped to the DSP inputs. See the "Audio Mixer and Mixer Controls" section for details.

5. ***audioClock* –** which clock to use for on board audio clock

   This is a readable and writable *Long* variable. There are 4 predefined constants for this variable: *Oscillator*, *ADAT1*, *ADAT2*, and *WordClock*, corresponding to the integer value of 0 to 3 in that order.

6. ***audioInPeak[18]* & *audioOutPeak[24]* –** these are readonly arrays representing the peak values of the audio channels at the inputs and the outputs of the DSP. They are values in dB and updated about every 32ms. You may use long term average of these peak values to decide if there are audio playback or not.

7. ***DayOfWeek* –** System day of the week.

   DayOfWeek is a read-only integer. Its value is the current day of the week. There are 7 predefined constants, one for each day of the week:

```
Sunday = 1
Monday = 2
Tuesday = 3
Wednesday = 4
Thursday = 5
Friday = 6
Saturday = 7
```

For examples,

```
If (DayOfWeek == Tuesday)
{
        // do something related to Tuesday
}

switch (DayOfWeek)
{
case Sunday:
        // do something for Sunday
        break;
case Monday:
        // do something for Monday
        break;
}
```

8. ***dins*** **–** All the digital inputs

   This is a read-only integer variable representing all the digital inputs. The least significant bit is *Din1*, the next bit is *Din2*, etc.

9. ***dinsDown*** **–** Down transition of all the digital inputs

   This is a read-only integer variable representing the down transition state of all the digital inputs. When push buttons are connected to the digital inputs, this is a quick way to check if any of the buttons got pushed. Just like *Din1.down*, reading this variable would automatically reset it to zero. Therefore, it is advisable to store its value to another normal integer variable if you intended to do multiple operations on its value.

10. ***dinsUp*** **–** Up transition of all the digital inputs

    This is a read-only integer variable representing the up transition state of all the digital inputs. When push buttons are connected to the digital inputs, this is a quick way to check if any of the buttons got released. Just like *Din1.up*, reading this variable would automatically reset it to zero. Therefore, it is advisable to store its value to another normal integer variable if you intended to do multiple operations on its value.

11. ***douts*** – All the digital outputs

    This is a readable and writable integer variable representing all the digital outputs. The least significant bit is *Dout1*, the next bit is *Dout2*, etc. If tally lights are connected to the digital outputs, setting this variable to zero is a quick way to turn off all the tally lights.

12. ***EndOfClip1, EndOfClip2, EndOfClip3, EndOfClip4*** – end of clip encountered

    These are readonly *Bit* variables, one for each of the 4 decoders. When a decoder is prepared to play back in repeat loop, its *EndOfClipX* variable would be set to TRUE when the playback reaches the end of the clip. This variable is cleared automatically once it is read.

13. ***GlobalSchedule*** – 7-day system-wise schedule enable/disable flag

    This is a readable and writable variable. When the RTC option is not present, this variable will always be false. When the RTC option is present, the 7-day system-wise schedule is enabled when the variable is set to TRUE, and disabled otherwise.

14. ***InSchedule*** – True when the controller has the 7-day scheduler turned on and the unit is within the scheduled running period.

15. ***isoPower*** – voltage of the power supply pin at the analog DB9 connector

    This is a readonly *Float* variable. Its value is the power supply voltage in volts of the power supply pin at the analog DB9 connector. It is network accessable.

16. ***iVolume1, iVolume2, …, iVolume26*** – mixer input volume control

    These are readable and writable *Float* variables. The value is the volume in dB to be applied to the corresponding mixer input. The value of these variable should always be less than or equal to zero. Not all of them are active. The number of active variables is determined by the number of inputs defined for the mixer matrix.

17. ***LampPower*** – voltage of the lamp power supply

    This is a readonly *Float* variable. Its value is the lamp power voltage in volts. It is network accessable.

18. ***netBit1, netBit2, …, netBit10*** – network accessable *Bit* variables

    These are generic *Bit* variables except that they are readable and writable from another 4MP3-MSC unit.

19. ***netFloat1, netFloat2, …, netFloat10*** – network accessable *Float* variables

    These are generic *Float* variables except that they are readable and writable from another 4MP3-MSC unit.

20. ***netLong1, netLong2, …, netLong10*** – network accessable *Long* variables

    These are generic *Long* variables except that they are readable and writable from another 4MP3-MSC unit.

21. ***Now*** **–** System time of the day.

    Now is a read-only integer variable. Its value is the current time of the day in number of video frames (30 frames/sec) starting from mid-night.

22. ***oVolume1, oVolume2, …, oVolume24*** **–** mixer output volume control

    These are readable and writable *Float* variables. The value is the volume in dB to be applied to the corresponding mixer output. The value of these variable should always be less than or equal to zero. Not all of them are active. The number of active variables is determined by the number of outputs defined for the mixer matrix.

23. ***oDelay1, oDelay2, …, oDelay24*** **–** mixer output delay control

    These are readable and writable *Long* variables. The value is the delay in milliseconds to be applied to the corresponding mixer output. The value of these variable should always be between 0 and 225. Not all of them are active. The number of active variables is determined by the number of outputs defined for the mixer matrix.

24. ***Playing1, Playing2, Playing3, Playing4*** **–** whether the MP3 decoders are playing or not

    These are read-only *Bit* variables, one for each of the 4 decoders. Its value is TRUE if the decoder is playing or paused. It is FALSE only if the decoder is stopped.

25. ***PlayLength1, PlayLength2, PlayLength3, PlayLenth4*** **–** The length of a prepared MP3 clip for each of the 4 decoders

    These are read-only *Long* variables. Its value is meaningless unless an MP3 clip has been prepared to be played back. Then, its value represents the duration of the prepared clip in number of video frames (30 frames/sec), taking into account of user-specified start and stop times defined in the clip.

26. ***PWMFreq*** **–** Base PWM frequency

    This is a write-only integer variable. It is the base PWM frequency of any digital output programmed for PWM mode. The same base frequency is used for all digital outputs. The unit is in Hertz. The minimum frequency allowed is 600 Hz and the maximum frequency is determined by the frequency response of the output hardware. It is recommended not to set the base frequency to be higher than 40kHz.

27. ***Reference*** **–** Start time of a cue in relative time mode.

    This is a write-only integer variable. This is a predefined system variable local variable. Every cue has its own copy. It represents the start time of a cue when the cue clock is in *Relative* mode. All subsequent time references inside the cue will be calculated relative to this start time.

28. ***RunTimeCode* –** turns on/off of SMPTE timecode output

    This is a *Bit* variable. When set to TRUE, SMPTE timecode is generated and available at the output pins on the backpanel.

29. ***TimeCodeOut*** – initialize the SMPTE timecode output

    This is a write-only *Long* variable. It is used to initialize the SMPTE timecode before the output is turned on. If the output is already turned on, changing this variable would hop the timecode to the specified value.

30. ***UdpReply* –** A *String* variable storing UDP packets sent to Port 10006. The content and length of this variable is updated every time a UDP packet is sent to Port 10006. This variable together with the UDP command allow a two-way communication between the show controller and another device.

31. ***Volume* –** Global playback volume.

    This is a floating-point variable representing the playback volume in decibels. The valid range is –61dB to 0dB, with 0dB being the power-up default.

S. Example Scripts

1. **Simple Video Loop**

```
#define START_FRAME          1000          // start at frame 1000
#define CLIP_LENGTH          5000          // 5000 frames long
Cue VideoLoop
{
        AutoStart;                   // automatic start at power up
        String discPlayer = port1;   // string variable mapped to port 1

        discPlayer.type = LD; // set type to LD
        discPlayer.baud = 9600;      // set baud rate
        VStartw discPlayer;          // spin up the laser disc player
        VSearchw discPlayer to “FR1”; // do a dummy search to set the
                                     // active search mode to frames
loop:
        VSearchw discPlayer to START_FRAME;   // search to start
        VPlayw discPlayer;           // start the play
        Idle for CLIP_LENGTH;        // wait for duration of clip
                                     // Vplayw doesn’t wait till the play is over,
                                     // it waits for the player to acknowledge that
                                     // it received the command!
        Jump loop;                      // loop forever
}
```

2. **Simple MP3 Loop**

```
Clip myClip
{
        filename = "sinewave.mp3";
}

Cue AudioLoop
{
        AutoStart;                      // automatic start at power up

loop:
        Prepare myClip to 1;            // prepare the clip
        ClStartw 1;                     // start the playback and wait till it is done
        Idle for 30;                    // wait for 1 second
        Jump loop;
}
```

3. **MP3 Playback On Demand**

```
Clip myClip
{
        filename = "sinewave.mp3";
}
Bit button = Din1;                      // A push button is connected to digital input 1
Cue AudioOnDemand
{
        Bit tmp;
        Enable if button.Down;          // run this if somebody pushed the button

        Prepare myClip to 2;            // prepare the clip
        ClStartw 2;                     // start the playback and wait till it is done
        tmp = button.Down;              // clear any pending pushes during the playback
}
```