CUBASE VST 5

MIDI Mixer and Mix Tracks

Mac

Steinberg

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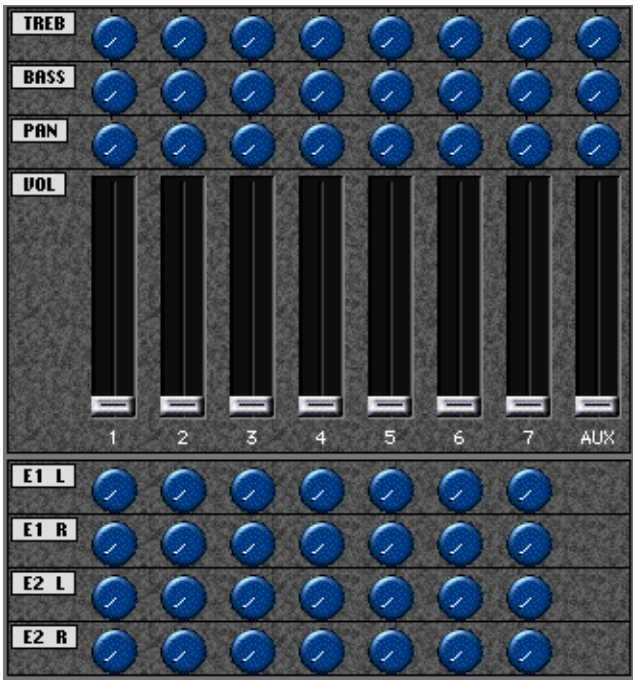
The MIDI Mixer and Mix Tracks

Introduction



Example Mix Map.

Cubase VST's MIDI Mixer window allows you to control MIDI devices for other functions than the regular “sequencing” ones. It works as a regular mixer for MIDI instruments (controlling volume, mute, pan etc), but it can also work as an editor panel for various instruments, effect devices etc.

The basic steps for using the Mixer are these:

1. **Create a Mixer Track.**
2. **Load the Mixer map you want to use (if you already have one on disk that fits your purposes).**

❒ **If you load a Mixermap that was created in an older version of Cubase, you will be prompted to either convert the map to the new format or leave it as it is. The difference between the two formats is purely graphical.**

3. **Set up the Mixer Track to use the Mixer Map you loaded.**
   Each Mixer *Track* is “assigned to” a Mixer *Map*.
4. **Create a Part for the Mixer Track.**
5. **Open the Mixer window by double clicking the Part.**
6. **If needed, create new Mixer Objects (faders etc) or edit the settings for the ones already existing.**
7. **“Play” the Objects and – if you so wish – record your actions.**

❒ **This chapter discusses various types of MIDI Events. You won’t need to know that much about MIDI to use the MIDI Mixer, but if you want to create your own MIDI Mixer Objects, you have to have at least a basic knowledge.**

About Mixer Tracks and MIDI Thruput

The Mixer Tracks are only for recording Mixer data, created by the program itself. You should not try to record MIDI data with a Mixer Track selected.

If you select a Mixer Track and play your MIDI keyboard, you will note that Cubase VST behaves as if you had selected a MIDI Track that was set to thru-put on the Modem Port and with MIDI Channel “Any”.

Loading Mixer Maps

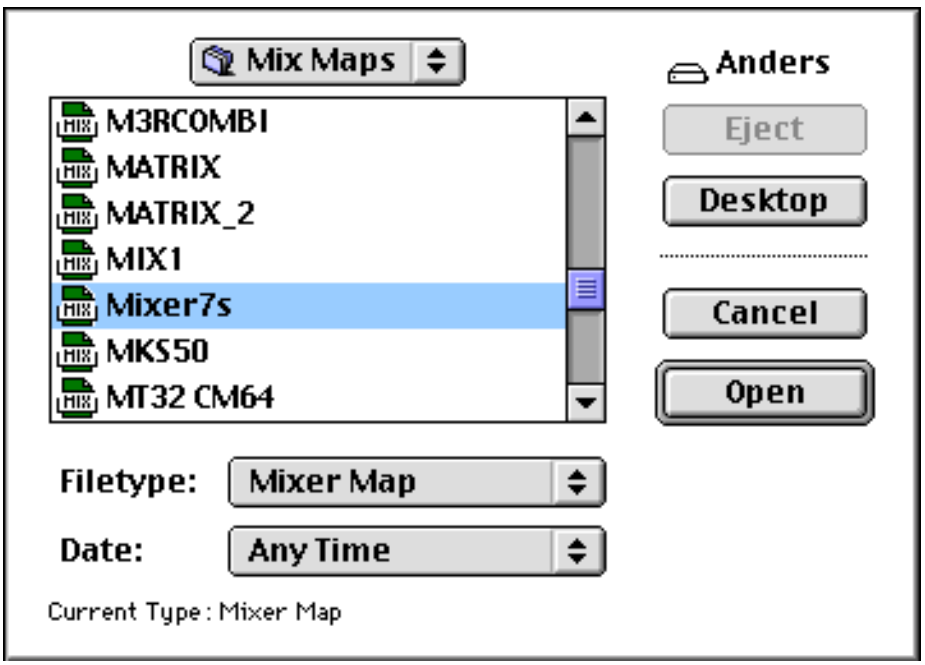
1. **Select a Mixer Track or create one.**
   See the Getting Started book for details.

2. **Pull down the Output menu for the Track.**
   The Mix Maps pop-up menu appears.

3. **Select “Load Mix Map”.**

❒ **You can have up to eight maps in memory at the same time.**

4. **Click Load and use the file dialog to locate the desired Map on disk.**
   Included on the Cubase VST CD you will find a number of maps for controlling various MIDI equipment.



❒ **Some of these maps have been created by users, and Steinberg can therefore not guarantee their functionality.**

5. **If desired, load more Mix Maps.**
   If you check the Output column for the Mix Track, you can see that it displays the (last) Map you have loaded. If you open the Mix Maps pop-up, all loaded Maps are listed.

Saving and Naming Mixer Maps

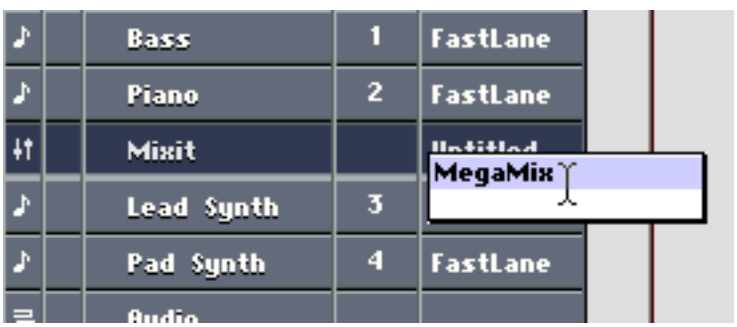
Naming a Mixer Map

There are two ways to name the Mixer Map:

- **In the MixTrack Output column.**
- **In the Inspector.**

The procedure is the same regardless of which method you use.

1. **Double click on the existing name in the list.**
   A text box appears.
2. **Write in the new name.**



Naming a Mixer map.

Saving one Mixer Map to Disk

1. **Open the Mixer Map pop-up menu from the Track Output or the Inspector.**
2. **Select a map in the list.**
3. **Open the pop-up again and select Save Mix Map.**
4. **Use the File dialog to specify name and location for the map.**
5. **Click Save.**

Saving Mixer Maps with the Song

When you save the Song, all Mixer Maps are saved with it. See “File Handling” in the Getting Started book.

Opening the Mixer Window

Opening a loaded Map

1. **Set up the Mixer Track to use the desired Map as described above.**

Setting a Track to use a loaded map.

2. **Create at least one Part on the Track.**

3. **Double click on the Part or select Edit from the Edit menu.**
   The Mixer window with the map appears.

Opening an empty Map

1. **Open the Mixer Map pop-up menu from the Track Output or the Inspector.**

2. **Select “New Empty Map”.**

3. **Create at least one Part on the Track.**

4. **Double click on the Part.**
   The Mixer window with the empty map appears. You can now create Objects, rename the map and save it to disk.

About the Objects

The MIDI Mixer window works with *Objects*. These Objects are graphical representations of faders, pots, “steppable” numerical displays and switches. These Objects send out the kind of MIDI-information you “program” them to do, from notes to System Exclusive Events. Practically any kind of MIDI data can be generated from the MIDI Mixer window.

Object Types

Below we’ll introduce the various type of Object with hints on what they do and how they are played. For information on how to create your own, see page 23.

Vertical fader

The vertical faders can be any length, and can have one of three widths. In the widest one, the current value is displayed in the “handle”.

Horizontal fader

Same as above but moving horizontally. Horizontal faders are always one height only.

Dial

Dials (knobs) can either have their lowest setting all the way to the left or they may be centered (like a pan pot on a mixing desk). They can be either red, blue or green in color, and one of three sizes.

A “Centered Scale” dial and a regular dial.

On/Off Switch

These can be used to turn things “on” or “off” or to set devices to various “modes”.

When the switch is “on”, it displays a green light.

Display

This is a bit like an LCD display that can be used to send out values. It can be set to display in red or green.

Backgrounds and Texts

There is also one type of Object that doesn’t output any data at all, Text Objects, which simply display some text and graphics on the screen.

❒ **The maximum number of Objects (all types) in a MIDI Mixer is 128.**

About Object’s MIDI Channel and Output settings

Each Object sends its data to a certain MIDI Out and MIDI Channel. It might be that the Objects in the maps you get with Cubase VST are set up to transmit to other outputs and on other MIDI Channels than your equipment is set up for. In this case you have to change this for individual Objects or for all Objects in the map. See page 30.

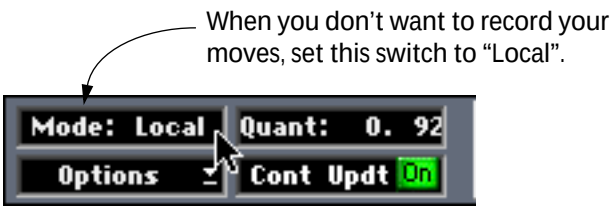
About the Toolbox

Playing the Objects

When we refer to “playing” the Objects we mean operating them as in “pushing faders”, turning knobs”, pressing buttons” etc.

Using the Mouse

1. **Click on the “Mode:” switch in the upper-left corner, until it says “Local” (not “Write” or “Replace”).**
   This is to make sure your action does *not* get recorded. If you *do* want to record your “playing”, see page 15.



2. **Open the Toolbox and select the Play tool.**

- **If the Object is a fader, drag the handle up and down (vertical fader) or sideways (horizontal faders). Or click somewhere on the fader, and the handle jumps there.**
- **If the Object is a dial, hold the tool over it, press the mouse and turn clockwise to increase the value or counter-clockwise to decrease.**

- **If the Object is an On/Off Switch you change its state by clicking on it.**
- **If the Object is a display you increase/decrease the value by pressing the mouse over the Object and then change the value as usual.**

Using the Keyboard

1. **Select the Edit tool from the Toolbox.**
2. **Click on the Object to select it.**
3. **Press the [↑] or [↓] keys on the computer keyboard.**
   If you hold down [Shift] the value changes in steps of ten.

Playing Master Objects

Some Objects can be Masters, that is they control other Objects. See page 32.

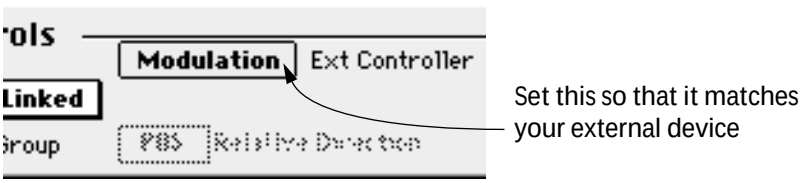
Playing Objects via MIDI

You can play the Objects via MIDI. This is convenient if you for example have a "fader box" that can transmit MIDI Controller messages.

1. **Select the Edit tool from the Toolbox.**

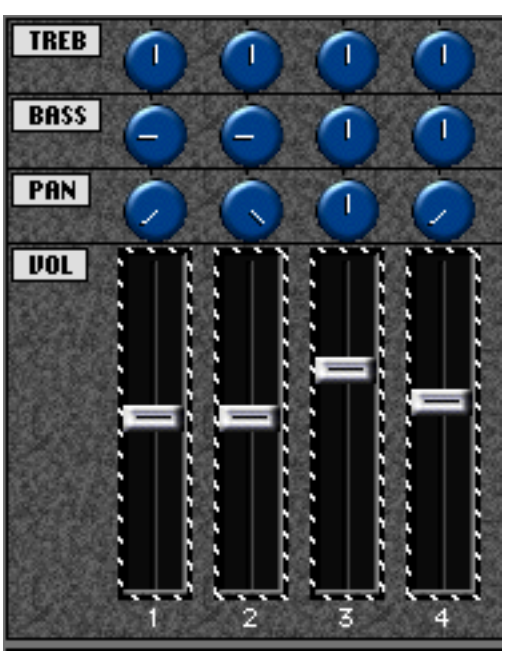
2. **Press [Option] and double click on the Object you want to control via MIDI.**
   The Object dialog appears.

3. **Change the "Ext Controller" setting so that it matches the Controller message that your MIDI fader box or similar is transmitting.**



4. **Continue to set up other Objects in the same way.**

5. **If you only want to play one or a few Objects at a time, pull down the Options pop-up Options menu and make sure it says "MIDI To Selected" (not "MIDI To All"). Then select the Objects you want to Control, using the Edit tool.**
   This allows you to have the same Controller type controlling several different Objects, and then decide which to actually play by selecting. This is convenient if you have a limited number of "faders" or similar on your external device.



With "MIDI To Selected" active, external control will only work on the selected Objects (in this case, the faders).

6. **If you want to Control all Objects, pull down the pop-up Options menu and make sure it says “MIDI To All” (not “MIDI To Selected”).**
   Make sure the device you are using for transmitting MIDI to the Mixer is connected and set up correctly.

With “MIDI To All” active, external control will work on all Objects

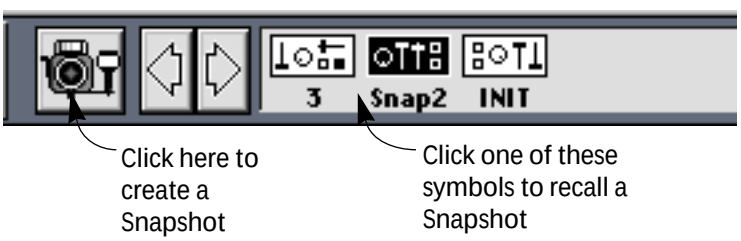
7. **Move the faders (or similar) on the device.**

Snapshots

If you use the Play tool to set up the Objects for a mix, you can store the setup as a *Snapshot*.

Creating a Snapshot

1. **If you want a Snapshot of all Objects, make sure that none of them are selected. If you want to take a Snapshot of just some Objects, select these.**
2. **Click once on the camera icon your new Snapshot appears beside it.**
   Cubase VST selects a random picture for each Snapshot for you! If you create more Snapshots than fit in the window, you can scroll the list using the arrows.



Recalling a Snapshot

By clicking with the mouse on any of the Snapshot icons, the Objects are set to the values stored in the Snapshot. This allows you to recall a complete mix at any time.

❒ **This doesn't mean that the Snapshot is recorded as a permanent part of your music, see page 16.**

Re-programming a Snapshot

If you wish to *re-program* a Snapshot, setup the Objects, hold down [Shift] and click on the Snapshot you want to replace. The new settings are now stored in that Snapshot.

Deleting a Snapshot

1. **Hold down [Command] and click on one of the Snapshot icons.**
2. **Click Delete in the dialog box that comes up.**

Naming Snapshots

If you double-click on the number/text below a Snapshot, a dialog box opens up where you can enter a (short) name as usual.

Recording Mixes

Preparing for Recording

1. **Create a Part that spans across the length of the Track that you want to record on.**
   In many cases the best alternative is to create a Part that spans the entire piece.

❒ **Parts are not created automatically when recording from the Mixer, so the step above is a must!**

2. **Double click on the Part to open the Mixer.**

Recording and Editing Static Mixes

A static Mix is sort of like a Snapshot. It is used to set all Objects to specific values at one certain position.

By Playing the Objects

1. **Move to the Song Position to where you want to insert a new mix.**
   Make sure you the Part is long enough to cover recording of mixes for the entire song!

2. **Make sure Cubase VST is stopped.**

3. **Put the Mixer in "recording" mode by clicking in the "Mode:" field in the upper-left corner until it says "Write".**

Mode set to "Write".

4. **Set the Objects to the desired values.**
   Only the ones you actually use are recorded. You may move e.g. a fader up and down as much as you wish, it is only the last setting (the one you leave the Object at) that is recorded.

   The settings for each Object are stored as a Special MIDI Mixer Event in the Part, at the current Song Position. One Event is created for each Object you "play".

5. **When you are finished, either switch back to Local Mode, or move somewhere else to Write another mix. When you play back the music, all the Objects will be updated at the correct position.**

❒ **To make your Object recording play back, you have to have the MIDI Mixer in Write or Replace Mode.**

By Recalling a Snapshot

You can also Write a complete Snapshot, which records one Event for each Object. This can be done in two ways:

Method 1:

- **Proceed as above, but instead of setting up the Objects, click on the Snapshot icon that recalls the right Snapshot.**

Method 2:

- **Put the MIDI Mixer in Write Mode. Start Playback. When the Music reaches the right Position, recall the Snapshot on the fly.**
  You can recall as many Snapshots as you like during one "take", they will all be recorded at the right Positions. Make sure the Part is long enough to cover recording of mixes for the entire song! Stop Playback when you are finished and switch back to Local Mode or continue recording as described above.

❒ **If you later re-program a Snapshot, this doesn't change your recording in any way.**

Replacing a Static Mix

In Replace Mode, Cubase VST records no new data, but replaces the values of existing MIDI Mixer Events. This is useful if you for instance have recorded a static mix at the beginning of a Song and decide that one of the volumes is too low, or for some other reason want to make changes to Events already recorded. Replacing is best done while Cubase VST is stopped.

1. **Move to the same Position as, or some Position just after the Event(s) that you want to replace.**
2. **Set the MIDI Mixer to "Replace" Mode by clicking in the "Mode:" field.**
3. **Set the Object(s) to the new value(s), or recall a complete Snapshot.**
   Cubase VST now tracks your recording backwards from the current Position. The first MIDI Mixer Event found for each Object is replaced with the new values. If no Event is found (within the Part) a new Event is inserted at the beginning of the Part.

Recording and Editing Dynamic Changes

You can also record any Object-actions while the music is playing. This allows you to create *dynamic* changes in timbre, volume or anything else you can control via an Object.

1. **Put the MIDI Mixer in "recording" mode by clicking in the "Mode:" field until it says "Write".**
2. **Start Cubase VST at any Position, in Cycle Mode if you wish. Play the Objects. Remember to stay within the Mix Part.**
3. **Stop Cubase VST when you are finished.**

   Your actions are now recorded as MIDI Mixer Events. When you play back the music, the Objects will move as they did when you used them, and their MIDI messages are sent out.

❒ **To make your Object recording play back, you have to have the MIDI Mixer in Write or Replace Mode.**

Redoing a Dynamic Recording

If you're not satisfied with what you did, you may decide to redo the whole take. Use any of the methods described on page 19, to erase Events for one or more Objects and redo the take.

Punching In on Dynamic Recordings

If you record the actions of an Object again, in Write mode, you can punch-in on each Object. This is how it works:

1. **Set the Mixer to Write mode and start Playback for recording, as describe above.**
2. **Press the mouse button over one Object, and keep it pressed. Play the Object if you like or hold the mouse still.**
   As long as you keep the mouse button down, the old Events created with that Object are erased and new ones are put in if you Play the Object during the take. This means that you can easily replace e.g. one fader movement among many, by just redoing it.
3. **Release the mouse button to punch out.**

Recording Guidelines

- It is easy to create a large number of Events from the MIDI Mixer. Cubase VST can handle the output, but MIDI may not be able to. System Exclusive messages are long MIDI messages, and if you only use one MIDI Output you might run into MIDI problems. If something can be achieved with a Static mix, this is preferable to a Dynamic recording.
- If you don't want a true "fade", but rather a direct change in value, you should click somewhere on a fader to make the handle jump there (instead of dragging the handle there). This creates fewer Events.
- Use the MIDI Mixer's Quantize value to make sure that no more Events are recorded than you actually need.
- Notes always have timing priority over other Events, so for example a volume change should be put slightly before the note, not on the same tick.
- If you have System Exclusive messages in a Snapshot or static mix, record them slightly early, since many synthesizers need some time to process System Exclusive data.
- If you have made a large Snapshot or static recording that sets up all your synthesizers at the beginning of a Song (remember that you can have up to 128 Objects!) record it in a one bar countdown, to avoid MIDI hiccups at the first downbeat of the Song.

Deleting MIDI Mixer Events

Deleting Events created by one Object

1. **Select one of the three Erase tools from the Toolbox.**
   Use the illustration below to decide which tool to use:

Erase all Events from the current Song Position to the end of the Part.

Erase all Events from the beginning of the Part up to the current Song Position.

Erase all Events in the Part inside the Locators.

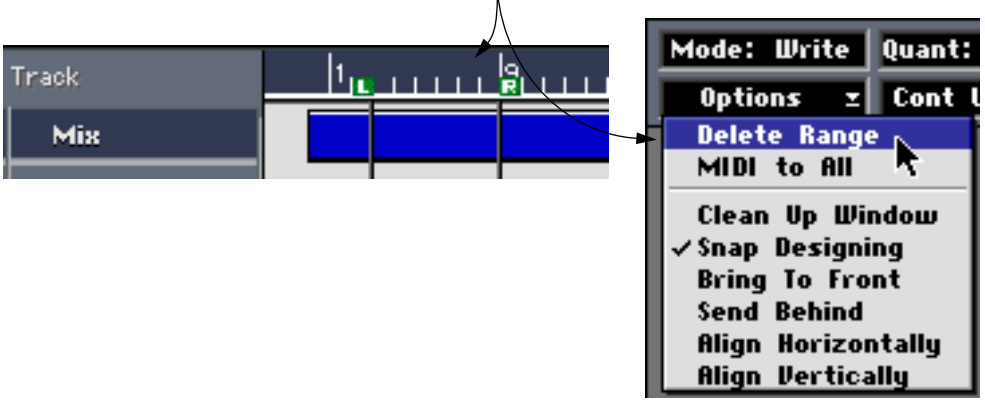
2. **Click on the Object that produced the Events.**

Deleting Events created by all Objects

1. **Set up the Left and Right Locator so that they encompass the range where you want to erase.**

2. **Pull down the local Options menu and select "Delete Range".**
   This deletes all MIDI Mixer Events (for *all* Objects) between the Left and Right Locator within the Part.

Set up the Locators and select Delete Range from the Options pop-up menu.



Using Quantize and “Cont Updt”

These items are found just below the window’s title bar.

Quantize

- **Use this value to decide how precise your recording shall be. This value is in ticks and defines how often Objects are checked for changes, when recording dynamic changes.Some changes, like Pitch Bend, have to be recorded with a small Quantize value to feel smooth. Others, like for example Panning, can be recorded with higher values to save memory and make editing easier.**

Continuous Update

This is an On/Off function for the Object movements on the screen. If you have this set to On, any changes are always shown. If you set it to Off and move for example a fader, the other Objects will not be updated. This is convenient if you have a lot of movement going on, on the screen, and wish to concentrate on writing Events with one Object.

Editing Mixes

Arrangement Editing

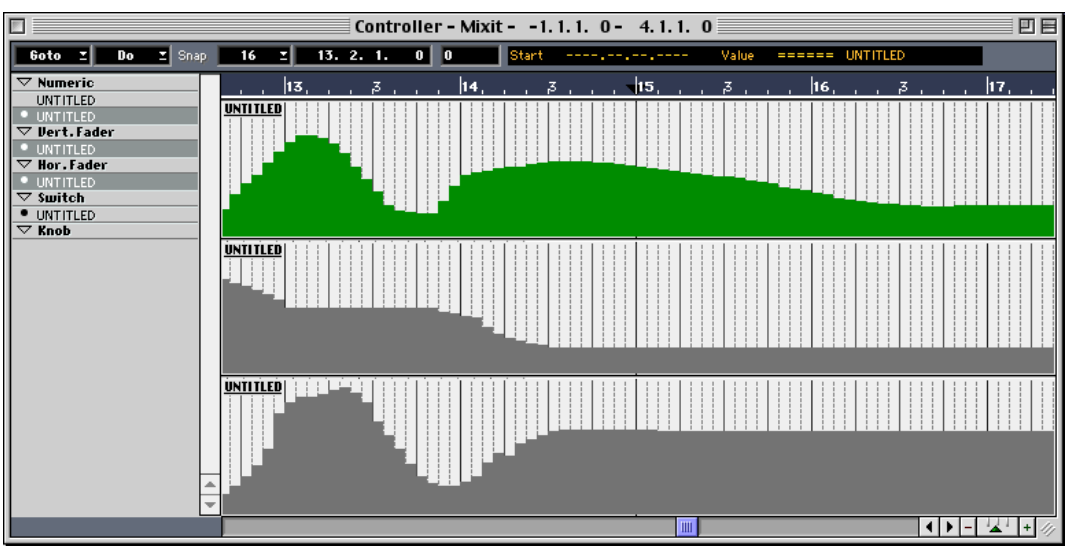
Once Mixer data has been recorded into a Part, that Part can be handled like any other. Which means that you can Cut, Copy, split, merge, duplicate, move or whatever you need to do, to apply that certain “scene” to any part of your Song.

Detailed Editing

The Events recorded from the MIDI Mixer window are actually not MIDI Events. They are “special” Cubase VST Events. When these special Events are *played back through the MIDI Mixer Objects*, MIDI Events are created and sent out to your equipment.

Editing in the Controller Editor

All Special Events can be edited in the Controller Editor. Double clicking an Object with the Edit Tool opens the Controller Editor. If you select several Objects, all of these special Events will be “stacked” in the Controller Editor window:



Several events in the Controller Editor.

Editing in the List Editor

The Special Events can be edited from List Edit. You have to close the Mixer window before you can select the List Editor.

This column shows the Object's value.

This column shows the name of the Object that produced the Event.

Position		Length	Val1	Val2	Val3	Event Type	Chn	Comment
4. 4.	0	----.----	0	45	---	Mixer	--	Volume 2 -
1. 1.	0	----.----	1	11	---	Mixer	--	Volume 1 -
1. 1.	0	----.----	4	62	---	Mixer	--	Pan 2 -
1. 1.	0	----.----	0	75	---	Mixer	--	Volume 2 -
1. 1.	0	----.----	2	63	---	Mixer	--	Pan 1 -
1. 2.	0	----.----	2	15	---	Mixer	--	Pan 1 -
1. 2.	0	----.----	1	12	---	Mixer	--	Volume 1 -
1. 2.	0	----.----	4	58	---	Mixer	--	Pan 2 -
1. 2.	0	----.----	0	52	---	Mixer	--	Volume 2 -
1. 3.	0	----.----	1	14	---	Mixer	--	Volume 1 -
1. 3.	0	----.----	4	55	---	Mixer	--	Pan 2 -
1. 3.	0	----.----	0	55	---	Mixer	--	Volume 2 -
1. 4.	0	----.----	2	16	---	Mixer	--	Pan 1 -
1. 4.	0	----.----	1	16	---	Mixer	--	Volume 1 -
1. 4.	0	----.----	4	50	---	Mixer	--	Pan 2 -
1. 4.	0	----.----	0	58	---	Mixer	--	Volume 2 -
2. 1.	0	----.----	2	18	---	Mixer	--	Pan 1 -
2. 1.	0	----.----	1	17	---	Mixer	--	Volume 1 -
2. 1.	0	----.----	4	47	---	Mixer	--	Pan 2 -
2. 1.	0	----.----	0	60	---	Mixer	--	Volume 2 -

Mixer Events in List Edit.

Editing in Logical Edit

You can also perform operations on special Events from Logical Edit. See the Logical Edit chapter.

Closing the Mixer Window

- Closing the window by clicking the close box or by pressing [Return], saves all changes made since you last entered the MIDI Mixer window.
- Pressing [Esc] closes the window but cancels all changes. That is, this cancels all recordings of Events, but changes to Objects (see later in this document) are not cancelled.

Advanced Info About the MIDI Mixer Events and Objects

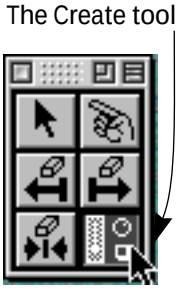
- MIDI Mixer Events are chased within the Part if the Chase Events function is turned on, on the Options menu. In practice this allows you to even have System Exclusive Events chased through a Song.
- You *can* change the parameters for an Object, after you have recorded Events with it, but it might give confusing results, so it is probably best avoided.
- If you do a “Merge Tracks” of a Mix Track to a MIDI Track, your Mixer data will be converted into regular MIDI Events. This can be used as a means of further processing or editing your MIDI Mixer recordings.

Creating and Editing Objects

Creating a New Object

1. **Select the Create tool.**

The Create tool



2. **Drag a rectangle to make up the size of the Object in a free area of the window (it can be moved and sized later), or...**

Setting the size of the Object by dragging with the create tool.

3. **Click once to get an Object with a default size.**
   In either case, a dialog box opens up where you can change a number of parameters for that specific Object. These parameters are described on page 35.

4. **Fill out the Object dialog box.**

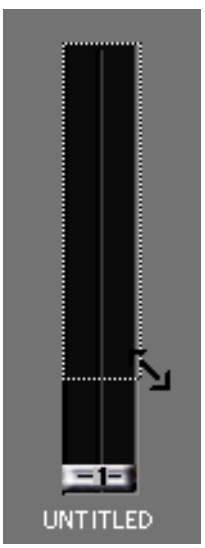
5. **Click on OK or press [Return] on the computer keyboard.**

Selecting Objects

- **If you have the Edit tool selected (the arrow), selecting is done just as with Parts in the Arrange window.**
- **If you use the Play tool or the Create tool, you have to hold down [Shift] while selecting.**

Sizing an Object

You can change the size of an Object by dragging its lower right corner, using the Edit tool or the Create tool. There is no visible “handle” in the corner, but you’ll easily find the right area after a little bit of experimenting.

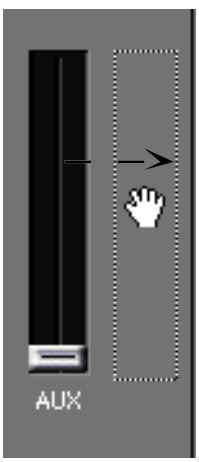


Changing the size of an Object.

Moving an Object

To arrange all your Objects into a neat display, you need to move them around.

1. **Select the Objects you want to move.**
2. **Select the Edit tool and dragging with the pointer positioned anywhere on one of the Objects (except on the sizing corner, of course).**

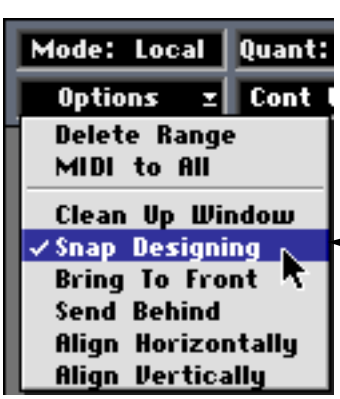


Moving an Object by dragging.

If you hold down [Shift], movement is restricted to horizontally or vertically only, depending on in which direction you start to drag.

Deactivating Snap

Normally, movement is restricted to invisible grid lines, four pixels apart (a pixel is the smallest dot on the screen). This makes it easier to arrange Objects in neat rows and columns. But, if you pull down the local Options menu in the mixer window, you find a choice called “Snap Designing”. This allows the snapping to be turned off (no check mark).



When this is activated, Object movement is restricted to a four-pixel grid.

Duplicating an Object

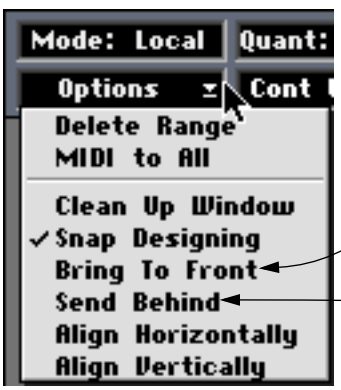
1. **Select the Edit (arrow) tool.**
2. **Hold down [Option] on the computer keyboard and drag it as when moving.**
   When you release the mouse, the same dialog box opens up as when you create a new Object.

Bring To Front and Send Behind

Objects may overlap on the screen. For example, putting faders and knobs on top of text Objects helps to make up nice graphic sections in a Mixer map.

Also, each time you create an Object, it is automatically put behind all other Objects, so it may be covered by another Object from the start! To fix this problem and to create nice looking maps with text Objects, you need to use Bring To Front and Send Behind.

1. **Select one or more Objects.**
2. **Select Bring to Front or Send Behind from the pop-up Options menu.**

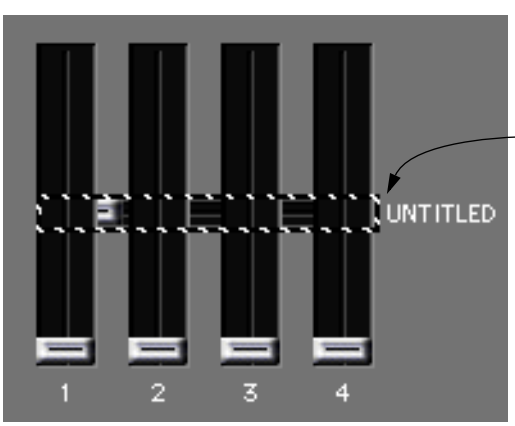


Use this item to put the selected Object in front of the other Objects.

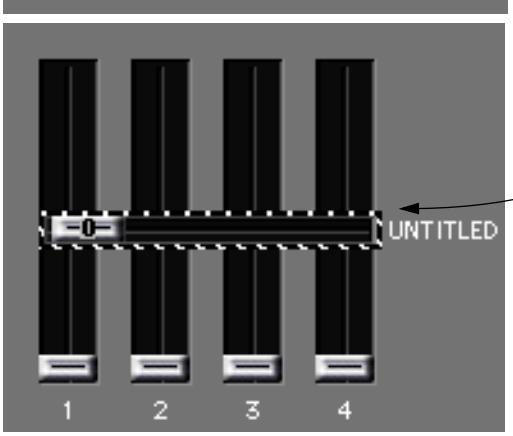
Use this item to put the selected Object behind the other Objects.

The selected Objects are now put on top of or behind all other Objects.

❒ **We don't recommend that you put several faders or knobs on top of each other (there is no reason), because the screen may get muddled.**



This Object is newly created, and therefore appears behind other Objects.



Use Bring To Front while the Object is still selected, and it is put in front of the other Objects.

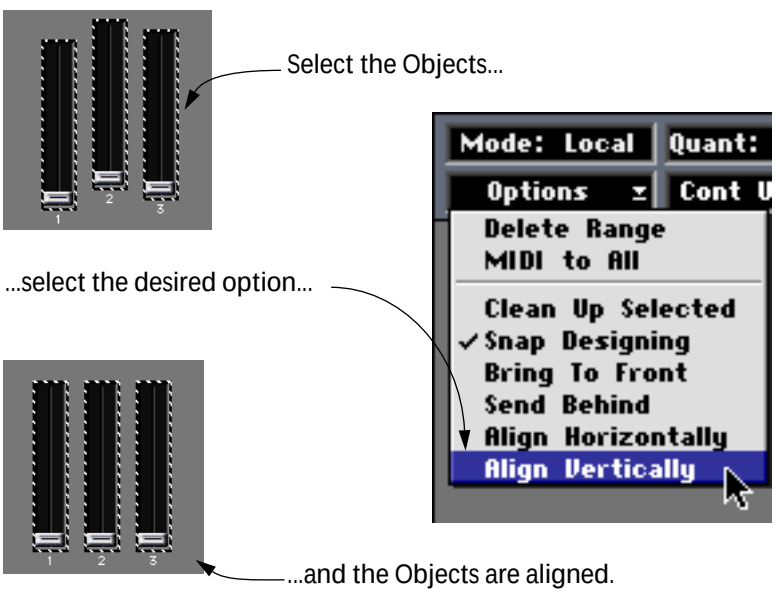
Align Vertically/Horizontally

To align the top of a number of Objects, proceed as follows:

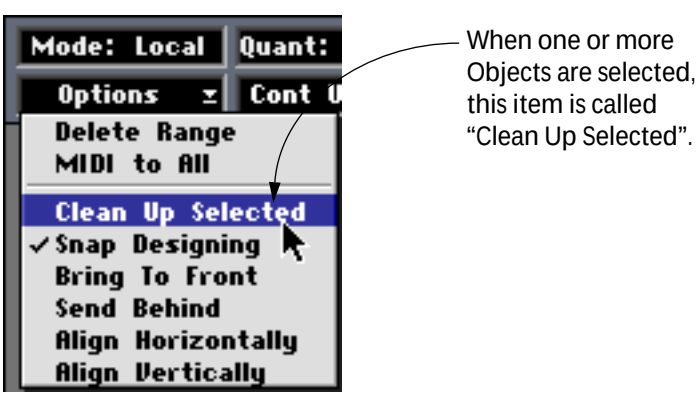
1. **Select the Objects.**
2. **Select Align Vertically from the pop-up Options menu.**

To align the left side of a number of Objects, proceed as follows:

1. **Select the Objects.**
2. **Select Align Horizontally from the pop-up Options menu.**



Clean Up Window/Clean Up Selected



This item on the Local Options menu automatically moves all selected Objects (or all Objects, if none are selected) to a sixteen pixel grid. This is similar to the Clean Up command in the Finder. This works best when you have for example created many faders by duplicating, and want their positions on screen automatically adjusted.

Deleting Objects

This is also done as in other places in Cubase VST.

- **Select the Objects and press [Backspace] or...**
- **Select the Objects and select Delete Object from the Edit menu.**

Cut, Copy and Paste

Mixer Objects can be Cut, Copied and Pasted, as any other Objects (events) in Cubase VST.

Making Setting for the Objects

Editing the Settings for one Object

1. **Select the Edit tool or the Create tool from the Toolbox.**
2. **Hold down [Option] and double click on the Object.**
   The same dialog box appears as when you create a new Object. See page 23.
3. **Fill out the dialog and click OK.**

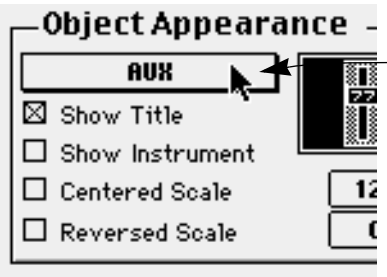
Editing the Settings for several Objects at the same time

You can change one ore more settings in the Object dialog and “copy” this setting to all selected Objects.

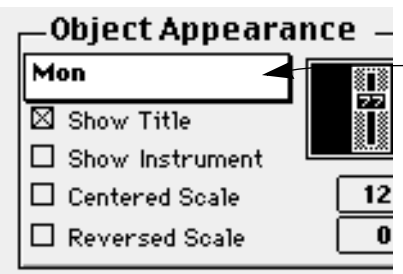
1. **Select all the Objects you want to make settings for.**
2. **Select the Edit or Create tool, press [Option] and double click on any of the selected Objects.**

3. Hold down [Option] and change the value.

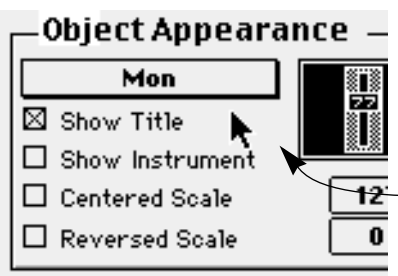
You have to keep [Option] down when *finishing* editing the value. That is, for example for naming and typing in values you must click outside the value field so that it closes, *before* you release [Option].



Double click on the current value...



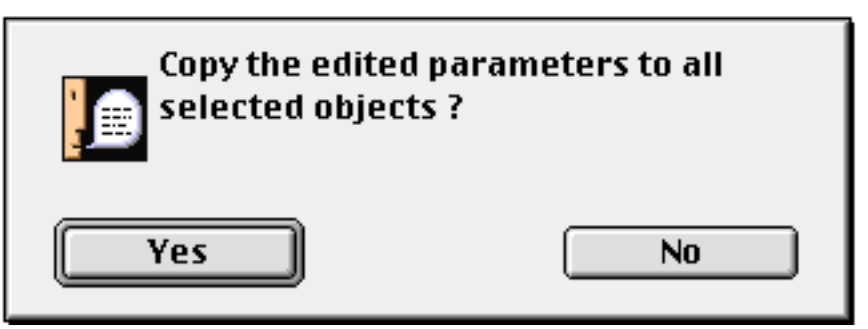
Type in the new value.



Hold down [Option] and click outside the value to finish the editing.

4. Click OK.

- **If you have several Objects selected, you will be asked whether you want to copy the edited parameters to those Objects.**



5. Click "Yes" in the dialog.

Advanced information

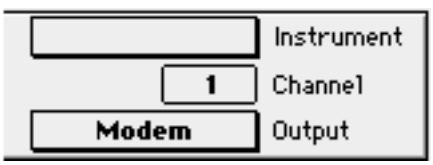
You may use [Option] when changing some parameters in the dialog box, while changing others without it. Only those parameters on which you actually used the computer key will be copied to the other Objects.

Changing the MIDI Channel and/or Output for one or more Objects

In the ready-made Mixer maps that come with Cubase VST, you might find useful Objects. However, they might be set to transmit to the wrong Output and on the wrong MIDI Channel, for your purposes.

You might also create your own Objects, but later move a device to another MIDI Output or change its MIDI Channel setting and therefore need to perform the following steps:

1. **Select all Objects for which you want to change the MIDI Channel/Output.**
2. **Select the Edit tool, press [Option]and double click on any of the selected Objects.**
3. **Locate the Output menu and change it if needed.**
4. **Locate the MIDI Channel setting and change that if needed.**



The MIDI Channel and Output settings

❒ **Do not change any other settings.**

5. **Click OK.**
6. **In the dialog that appears, click "Yes".**
7. **Set the Mixer to Local Mode (see page 11), select the Play tool and try out the Object.**

Working with Master Objects

You can group (or “gang”) several Objects, so that they behave a bit like groups on a regular mixing console. In each Group you can have one Master Object and as many Slave Objects as you like.

Setting Up

Master Object

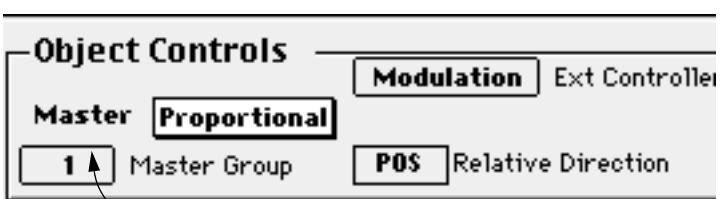
1. **Open the Object Dialog for the Object you want to be Master.**
   Only a fader can be a Master Object.

2. **Set the Master pop-up to “Direct Link” or “Proportional”.**

- Direct Link means that the Slave Objects will always have exactly the same value as the Master.
- Proportional means that the slave Object will move just as much as the Master, but keep its relative distance to the Master.

Use the first option when you want to Link several Objects, for example the panning of several sounds, and the second option when you for example want to use one fader to control the individual volumes of many sounds, as when using Groups on a regular mixing console.

3. **Enter a Group number for the Master.**
   All Objects with the same Master Group number are considered to belong to the same Group. Number 0 is also a Group, so when you start with new Objects they are all “members” of Group 0.



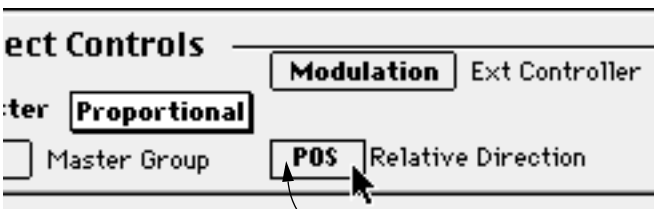
The Master Group setting.

4. **Close the Object dialog.**

Slave Objects

For each Object you want to be a slave to the Master you just have set up, perform the following:

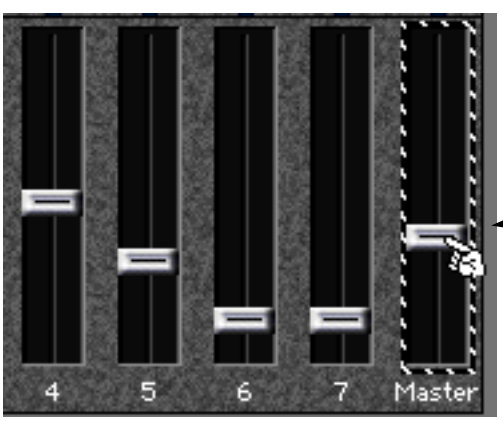
1. **Open the Object dialog box.**
2. **Set up the Object to transmit the desired data, as with any other Object.**
3. **Set the same Group number as for the Master.**
4. **If you want this slave to move in the same direction as the Master, set relative Direction to POS. If you want it to move in the opposite direction, set it to NEG.**



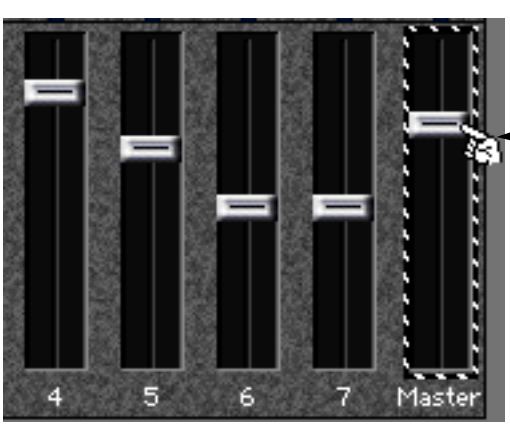
The Slave direction setting.

Playing the Master

- **Whenever you play a Master, the Slave Objects move with it.**



Drag the Master fader up...



...and the Slaves move with it.

- **To play a Master without affecting its "slaves", hold down [Option].**

Undo

In the MIDI Mixer window, you can Undo:

- Delete, Size, Move and Paste Object.
- Delete Events, either done with one of the Delete tools in the Toolbox or by using the Mixer's pop-up Options menu.

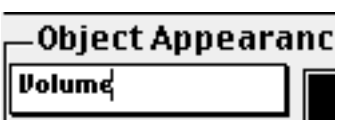
Creating an Object – A quick tutorial

Before we go into the details of the Object dialog box, let's create one fader that is used to output MIDI Volume.

1. **Open up any MIDI Mixer Map.**
   Either open an empty Mixer Map, or open one that you do not need, and delete all Objects in it (using Select All on the Edit menu and [Backspace]).

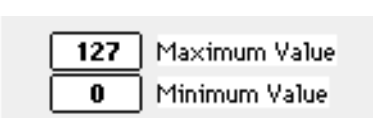
2. **Select the Create tool and double click somewhere in the window.**

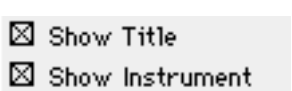
3. **Click in the name filed below "Object Appearance" in the dialog box that appears. Replace whatever text is there with the title "Volume".**



4. **Select the type of Object by clicking on the graphical symbol below. Choose the vertical fader.**

5. **Check that the Minimum and Maximum values are 0 and 127, that Title and Instrument are both shown (checked).**





6. **In the MIDI Message section of the dialog, pull down the Status Byte menu and select "CtrlChange".**

7. **Pull down the pop-up directly to the right of this (Extra) and select "MainVolume".**

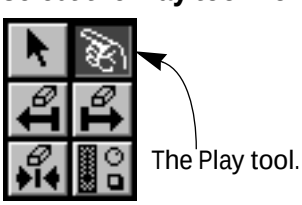
8. **Click OK or press [Return].**
   The dialog box closes and a fader appears on the screen.

9. **Move the mouse over the lower right corner of the fader and drag the corner of the fader so that it becomes as wide and as long as you want it to be (vertical faders can take on one of three widths).**

You have now created a fader that outputs MIDI Volume on the selected MIDI Channel. It is currently selected (that's why there is a border around it). Click in a empty space to deselect, if you wish.

10. Click on the "Mode:" button at the top of the MIDI Mixer window until it says Local (not Write or Replace).
This allows you to play around with the fader without recording anything.

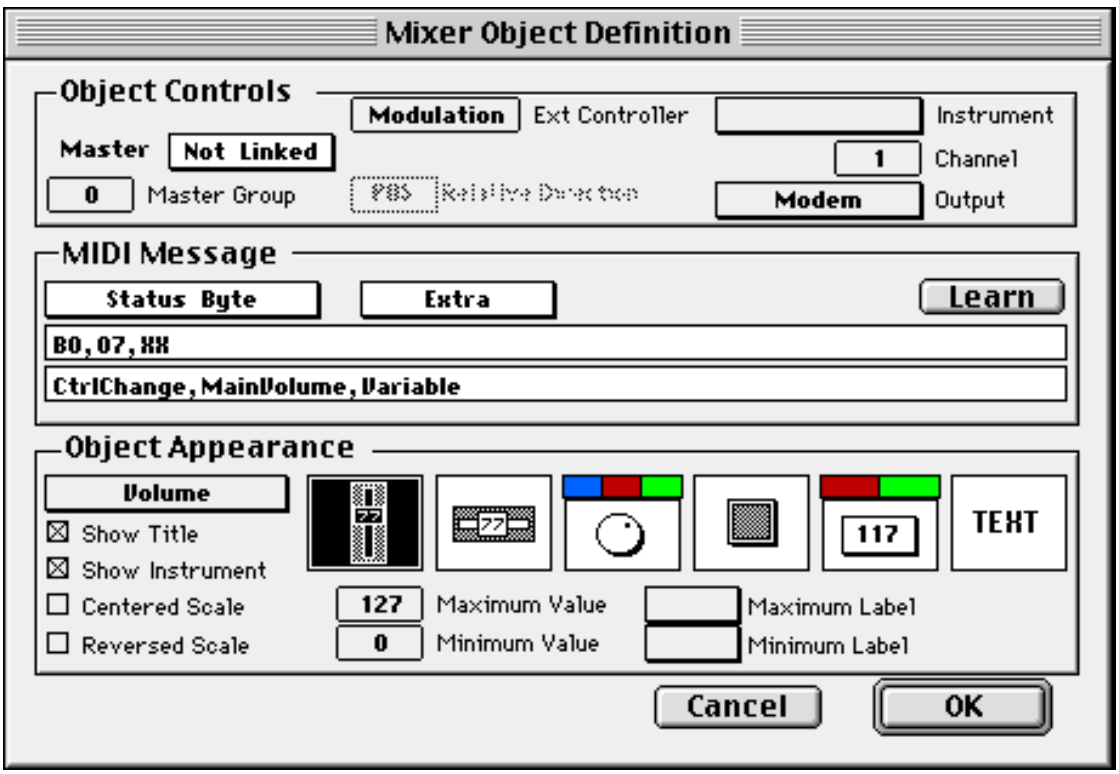
11. Select the Play tool from the Toolbox.



12. Move the fader up and down by dragging its handle, while playing your instrument.
The volume of the sound should change with the movement of the fader. If it doesn't, check that the instrument is set to receive Controllers (and especially number 7, MIDI Volume) on the right MIDI Channel. Also, some very old synths may not be able to react to MIDI Volume at all.

Congratulations! If everything worked, you have made up your first Object, with a very useful function. Save it to disk if you wish, or experiment by changing the values in the dialog box to see what you can come up with.

The Object Dialog Box

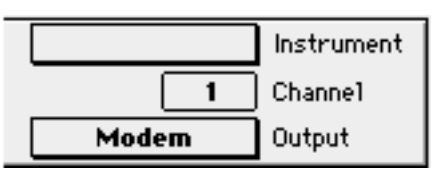


Introduction

Read as much as you wish of this text, and don't feel intimidated by its technical nature. If you don't wish to get into heavy MIDI-hacking, skip the details on the Input Line and the different types of messages and concentrate on the Status Byte and Extra menus and the Learn function, since these features alone allow you to make an Object without typing a single number!

Object Controls

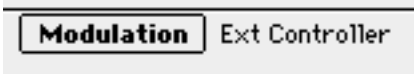
Instrument, Channel and Output



Each Object can transmit to a different MIDI Channel and Output. The combination of Channel and Output can of course be handled as an Instrument, as usual.

❒ **System Exclusive messages don't have a MIDI Channel value.**

Ext Controller



The Objects can be controlled ("played") via MIDI using MIDI Controller messages, as described on page 12. This field is used to select the Controller you wish to use for external control of this Object.

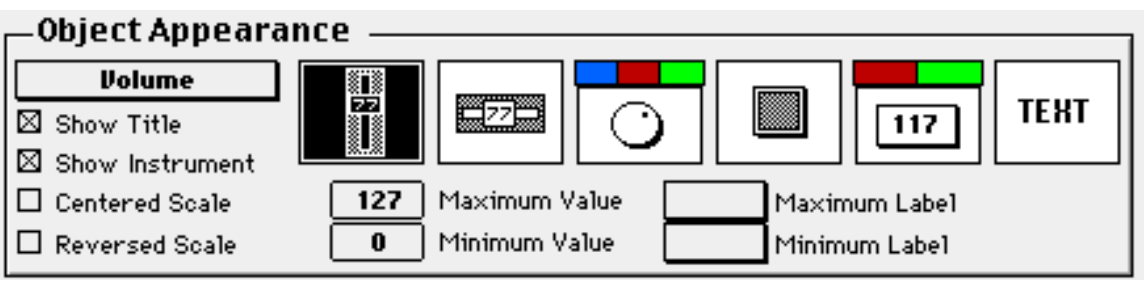
❒ **Observe that which MIDI Channel the Controller is coming in on is irrelevant. You therefore have to give each Object different Controller numbers**

External Controllers either work on *all* Objects or on the *selected* ones only, see page 12.

Master, Master Group and Relative Direction

These settings are described on page 31.

Object Appearance



Name

This is simply the Object's name. You edit the name directly in this field. Twelve characters are maximum.

Object type

The six icons represent the different types of Objects, as described on page 9.

For more info on Text Objects, see below.

Minimum and Maximum Values

You can set a minimum and maximum value for any "playable" (non-text) Object. The maximum range is 0 to 127. The minimum range is two adjacent numbers, for example 6 and 7 for all Objects except Switches.

- Many System Exclusive functions change between 0 and 1, so you could e.g. make up an On/Off Switch that sends out these values when you click on it.
- Another example: Controller switches (like Sustain Pedal) should have 0 for off and 127 for on. Use a Switch for this with 0 and 127 as min and max settings.
- If the Object type is a Switch, you can set *the same min and max value*, which allows you to send out exactly the same message each time you click on the switch. Use this for Static Controller messages like Mode Changes or for specific System Exclusive messages that should always be the same.

Minimum and Maximum Labels

If you wish you can also label the min and max values in the two small name-fields to the right of each value. These names are then shown beside the end positions for the faders and the dial.

Show Title and Instrument

By clicking in these two fields you can decide if the Object's name (as entered at the top of the dialog box) and Instrument setting (Output and MIDI Channel) should be displayed with the Object or not.

Centered Scale

For Dials you can decide if you want the center value indicated graphically above the knob. Some Controller messages, like Pan and Balance, are convenient to think of as having center values (for example "no panning") and changes that go "up or down" (pan left, pan right) from that position. For those you should select Centered Justification.

Reversed Scale

This parameter makes it possible to make an Object go "backwards", like for example a fader with the highest value at the bottom, and the lowest at the top. For On/Off switches this parameter is used to decide which value should be sent out when the switch is pressed/not pressed

Setting up Text Objects

Text Objects don't output any data. Use them to create borders, backdrops, names and other things that make your MIDI Mixer Map simply look better.

About overlapping Text Objects

Putting different style Text Objects on top of each other allows you to create backgrounds with various looks.

Selecting Borders and Fills

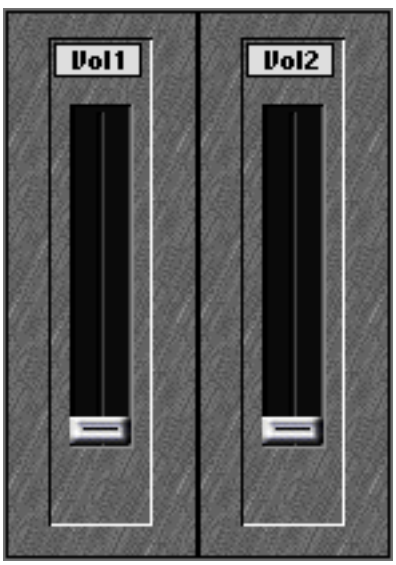
If you select the text Object icon, options for borders and fill patterns appear. Click on the combination of these that you desire.

Border types / Fill patterns.

Creating a 3-D Background

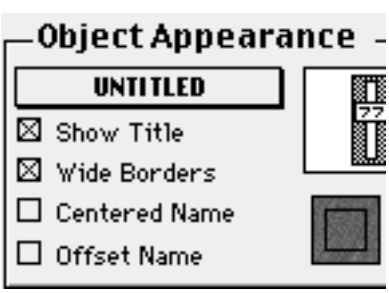
If you want a background that looks like the rightmost of the three border options, proceed as follows:

1. **Create a text Object slightly smaller than the total background. Use the rightmost border option and fill pattern grey for this Object. Also make sure "Wide Borders" is unchecked.**
2. **Make up another text Object, slightly bigger than the first one. Select the leftmost border type and grey pattern and uncheck "Wide Borders" again if needed. Click OK.**
3. **Move the Objects, size them and Bring them To Front and Send Behind until it looks as desired.**



A "3D" background made up of two overlapping text Objects.

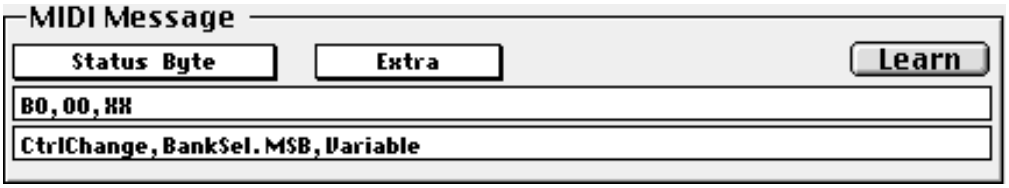
Show Title, Wide Borders, Centered Name and Offset Name



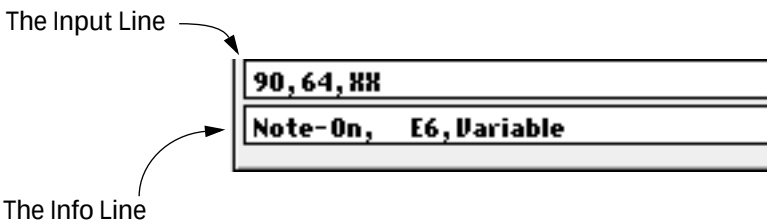
If you select the text Object icon, the check boxes in the Appearance part of the dialog are slightly different:

- If "Show Title" is ticked, the name of the Object is displayed inside it.
- By checking different combinations of "Centered Name" and "Offset Name" you can have the name put in the top left or top right corner, in the middle or in the center along the top border.
- "Wide Borders" allows you to select between thin and wide borders.

MIDI Message



The Input and Info Lines



The Input Line is the core of the Object. You use it to decide what MIDI messages the Object should send out.

If you are a real MIDI hacker you can just type in the message on the Input Line (the top line).

1. **Click once on the Input Line.**
2. **Edit and input text as usual.**

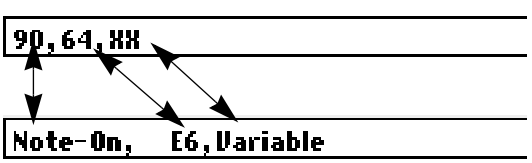
❒ **You must put in commas after each complete byte (each two characters).**

3. **Click with the mouse outside the Input Line.**
   The text is interpreted and displayed on the Info Line.

The Info Line

The decoded version of the message is shown on the Info Line with as much as possible interpreted into text that is fairly easy to understand.

Numbers are always shown in regular decimal format on the Info Line (not in hexa-decimal as on the Input Line). This allows you to use the Input and Info Lines for automatic conversion from hexa-decimal to decimal.



The Status Byte and Extra menus

If you are not used to typing hexa-decimal numbers (who is?), there are two local menus there to help you. One is called StatusByte, and on this menu you find a list of the possible Status Bytes, as described below. Select one and it appears on the line. Beside this is another menu, called Extra. This helps you with filling out the rest of the “form”. What you find on this menu depends on what kind of Status Byte you have selected or typed in, as described for each MIDI Message later in this text.

Learn

It is not all the time that you know exactly which controller number or note number you want an Object to send out. On for example a MIDI Controlled mixing console, each fader may send out a message that could either be a certain note number with different velocities or some Controller number with different values. In these cases, the Cubase VST Learn function will help you out. This method works with Notes, Controllers and System Exclusive messages. It can be applied to many situations.

1. **Check that the unit's MIDI Out is connected to Cubase VST.**
2. **With the Object dialog box open, move the fader, play the key, turn the knob, or do whatever you need to do on your MIDI device to input a couple of examples of the MIDI message you want the Object to send out.**
3. **Click on Learn.**

   On the input line you should now have a complete message, with the right Note number, Controller number, or a System Exclusive "string", with an XX inserted at the correct position.

❒ **The MIDI Channel setting is not "Learned", you have to set that yourself when applicable.**

About "Learning" System Exclusive messages

Only some synthesizers send *out* System Exclusive messages when you edit parameters on the front panel. If it does, this would then be the same message that you should send *in* to the unit to change that parameter via MIDI. This allows Cubase VST to automatically learn how such a message should be built up.

- The sending of Sys Ex messages from a unit can normally be turned on or off. Make sure it is turned on.
- To send out the right message you must select the parameter to be changed, and change its value a couple of times up and down.
- Do not confuse transmission of System Exclusive data with the Controller messages that are normally sent out just because you move the Data Entry knob or slider, or use the Up and Down or + and – keys on a unit (Controller number 6, 96 and 97).
- If the learning of the System Exclusive message has worked, you should probably find the manufacturers name in the decoded version of the message displayed on the Info Line.

❒ **Learning SysEx is not fool-proof since different manufacturers build their messages differently and by their own rules. Only experimentation can tell if it works.**

General rules for creating MIDI Messages

About Hexadecimal Numbers

Everything on the Input Line is in hexa-decimal format. This means that only numbers 0 to 9 and characters A to F (which means 10 to 15 in decimal notation) can be entered. You can type upper case (A-F) or lower case (a-f) letters, it doesn't matter which. When hexa-decimal numbers are indicated in this manual, the number (or letter) is followed by a subscript "16". 127 (decimal) is consequently written like this: $7F_{16}$. There are other ways of indicating hexa-decimal format also, (for example by a prefix $ or a suffix H or h) but the subscript format is used in the following text.

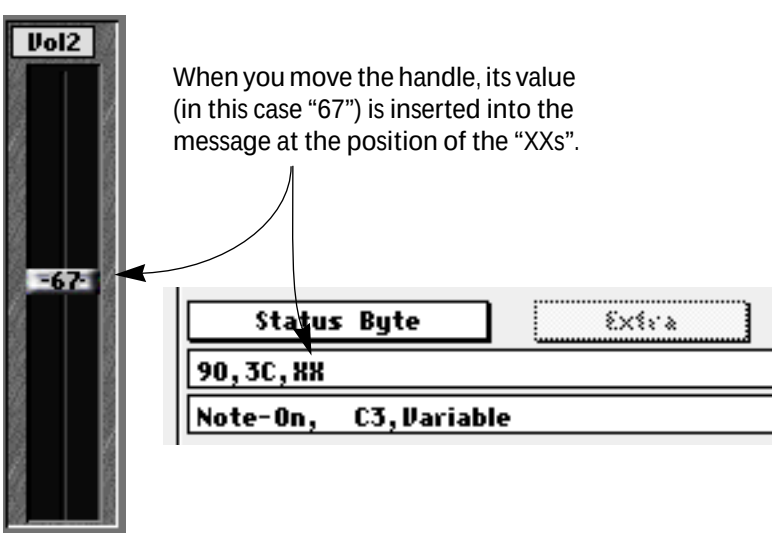
A table for conversion between Decimal, Hexa-Decimal and Binary formats is found on page 49. Different manufacturers use different formats (decimal, binary, hexa-decimal) in their documentation, so use this table to convert to hexa-decimal when you are copying messages from an operation manual or similar.

Each two characters between commas on the Input Line represent a byte, a number between 0 and 255. The idea of using hexa-decimal format is that it only takes two "digits" to represent all values between 0 and 255.

The Value Byte

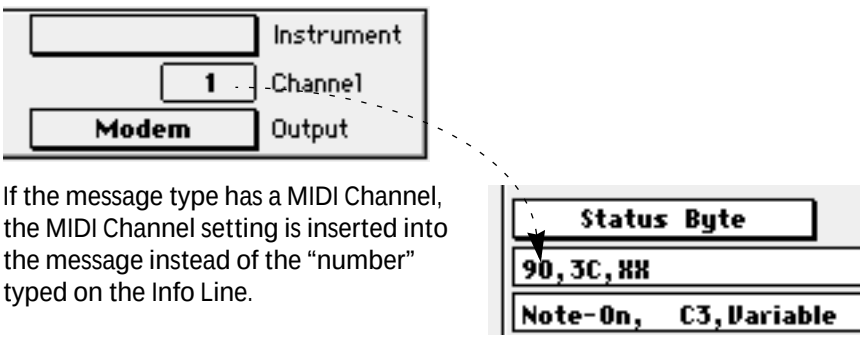
The bytes on the Input Line form the MIDI message sent out. Somewhere in your message you *must* enter XX (or xx). This is the variable, the value that changes when you use the Object. If the Object for example is a fader, this will be the position of the fader, the value that changes when you Play it.

Let's say that you type in "90,3C,XX" and move the fader handle from position 8 to 9. This will make the fader send out $903C09_{16}$. The first two bytes are the ones you typed in, the third byte is the new position of the fader.



How MIDI messages are organized

- All MIDI messages begin with a *Status Byte*, a code telling what type of message it is.
- After the Status Byte come one, two ore more *data bytes*. These are always between 00_{16} and $7F_{16}$ (0 to 127 decimal).
- Most MIDI messages contain a MIDI Channel number as a part of the Status byte. If the message on the Input Line is one of those, the Object will always send out its messages on the MIDI Channel selected at the top of the dialog box. Just as when you set a *playback* MIDI Channel for a Track in the Arrange window.



If the message type has a MIDI Channel, the MIDI Channel setting is inserted into the message instead of the “number” typed on the Info Line.

Error Checking

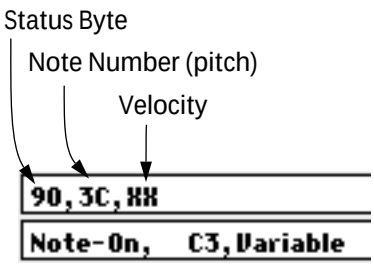
When you have typed or used the menus (or a combination of both techniques) to enter a message, you should click the mouse or press [Return] to let the program check for errors. Such errors could be: Other characters than the ones allowed, more than one Status Byte, no XX (variable) field, and so on. A dialog box will inform you so that you can correct the mistake.

Details about specific MIDI Messages

Notes

Note On messages start with 90_{16}. Note Off messages start with 80_{16}. The Status Byte menu always enters Note On status (90_{16}).

After the Status Byte should follow a note number (which key) and a velocity number. These both range from 0 to 127 (00_{16} to $7F_{16}$) and you can replace either one with the variable XX.

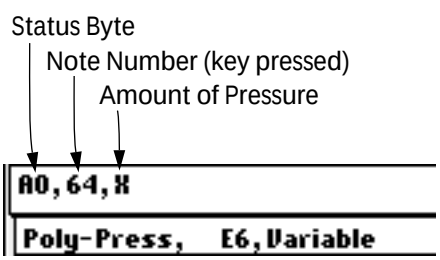


Sending out streams of Note Ons from for example a fader to your synthesizers, may not be such a good idea, since this will turn on a lot of notes without turning them off. But some MIDI mixing systems use Note messages to control volume and other functions, with for example one note number for each fader and the velocity value representing the fader's position.

Poly Pressure

This is a type of key pressure that is individual for each key. The first byte you get, when you select Poly-Press from the Status Byte menu, is $A0_{16}$.

After the Status Byte follows two data bytes, one that tells which key, and one that represents the amount of pressure. This can normally be used to control a number of parameters in a synthesizer, such as volume, vibrato or filter frequency. Use this instead of Channel Pressure (Aftertouch, see below) if you wish to have individual control of certain notes.



The Extra menu is not used for Poly Pressure.

Control Change

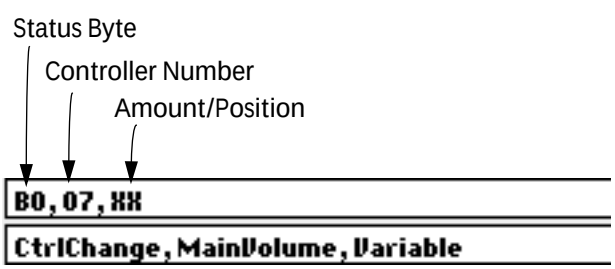
This is the most obvious purpose for the MIDI Mixer window. Controllers can be used for almost any function.

Controller messages start with $B0_{16}$ so this is what you get if you select CtrlChange from the Status Byte menu.

The second byte is the number of the Controller. If you have entered the Status Byte for Controllers, and pull down the Extra menu, a list of all Controllers (by their names) appears. Select the one you want.

BankSel.MSB	Modulation	BreathCtrl	Ctl 3	Foot Ctrl	Porta.Time
DataEntMSB	MainVolume	Balance	Ctl 9	Pan	Expression
FXControl1	FXControl2	Ctl 14	Ctl 15	Gen.Purp.1	Gen.Purp.2
Gen.Purp.3	Gen.Purp.4	Ctl 20	Ctl 21	Ctl 22	Ctl 23
Ctl 24	Ctl 25	Ctl 26	Ctl 27	Ctl 28	Ctl 29
Ctl 30	Ctl 31	BankSel.LSB	Modul. LSB	BrthCt LSB	Ctl 35
FootCt LSB	Port.T LSB	DataEntLSB	MainVolLSB	BalanceLSB	Ctl 41
Pan LSB	Expr. LSB	Ctl 44	Ctl 45	Ctl 46	Ctl 47
Gen.P.1LSB	Gen.P.2LSB	Gen.P.3LSB	Gen.P.4LSB	Ctl 52	Ctl 53
Ctl 54	Ctl 55	Ctl 56	Ctl 57	Ctl 58	Ctl 59
Ctl 60	Ctl 61	Ctl 62	Ctl 63	Damper Ped	Porta. Ped
Sostenuto	Soft Pedal	Legato Sw	Hold 2	SoundCont 1	SoundCont 2
SoundCont 3	SoundCont 4	SoundCont 5	SoundCont 6	SoundCont 7	SoundCont 8
SoundCont 9	SoundCont 10	Gen.Purp.5	Gen.Purp.6	Gen.Purp.7	Gen.Purp.8
Portamento	Ctl 85	Ctl 86	Ctl 87	Ctl 88	Ctl 89
Ctl 90	FX 1 Depth	FX 2 Depth	FX 3 Depth	FX 4 Depth	FX 5 Depth
Data Incr	Data Decr	Non-RegLSB	Non-RegMSB	Reg LSB	Reg MSB
Ctl 102	Ctl 103	Ctl 104	Ctl 105	Ctl 106	Ctl 107
Ctl 108	Ctl 109	Ctl 110	Ctl 111	Ctl 112	Ctl 113
Ctl 114	Ctl 115	Ctl 116	Ctl 117	Ctl 118	Ctl 119
Ctl 120	Reset Ctrl	Local Ctrl	AllNoteOff	OmniModOff	OmniModeOn
MonoModeOn	PolyModeOn				

The last byte in a Controller message is the value for the selected Controller, and this is probably where you will put your XXs, so that the Object can be used for adjusting the value of the Controller.



Controllers can be used for almost any purpose, some of them are defined by the MIDI standard and others are not. Many synthesizers and effect units (like reverbs) can be programmed to react to controller messages, and MIDI-controlled mixer systems use them for faders, knobs and other controls.

Figuring out exactly which Controller number does what may take some searching in the unit's operation manual, but the information should definitely be there. Often, on for example a signal processor, you can assign numbers to parameters yourself, like one Controller number for reverb volume, another for reverb decay, and so on. If you do this, start with the Controller numbers reserved for “user experimenting” 16-19 (10_{16}-13_{16}), and 80-83 (50_{16} to 53_{16}) to avoid number conflicts with other units. Remember that you may use the same Controller number for two different purposes on two different units as long as they receive on different MIDI Channels.

Registered and Non-Registered Parameter Numbers

The devoted MIDI fan can also use the Objects to send out Register Parameter numbers (RPNs) and Non-Registered Parameter Numbers (NRPNs). Proceed as follows:

- **To send a Registered Parameter number, input (in hex):**

  B0,65,MSB,64,LSB,06,DMSB,26,DLSB.

  The LSB and MSB should be replaced by numbers. They form the number of the Registered Parameter. You should also replace either the DLSB or the DMSB with the XXs and the other with a number, depending on how you want to change the value.

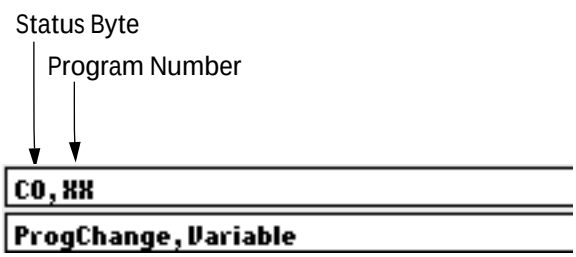
- **To send a Non-Registered Parameter number, input:**

  B0,63,MSB,62,LSB,06,DMSB,26,DLSB.

  The abbreviations should be replaced as with the registered parameters.

Program Change

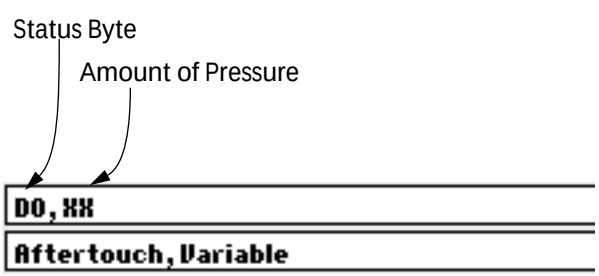
These messages are normally used to make an external unit switch to another Program (sometimes called Patch, Timbre, Set, Instrument, Combination or something else). Their Status Byte is $C0_{16}$. Program Change messages only have one value (the Program Number), so after the Status Byte is where your XXs go.



Aftertouch

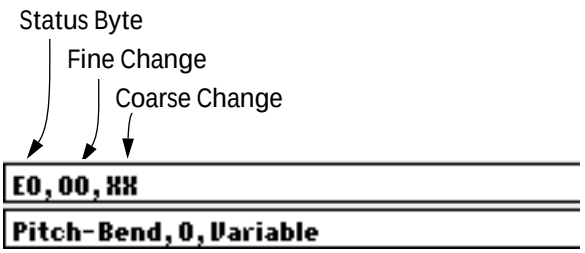
This is often called Channel Aftertouch or Channel Pressure. The first byte is $D0_{16}$.

Channel Aftertouch affects all notes by the same amount and can often be used for functions like vibrato amount, volume, filter cutoff and so on.



Pitch Bend

If you have come this far in the text you probably knew what Pitch Bend was before you started reading! The status code should read $E0_{16}$ in the dialog box. The two values that come after this represent coarse and fine changes. The coarse value (the second data byte) represents the full swing of a Pitch Bend wheel with 00_{16} as full negative, 40_{16} as middle (no Pitch Bend) and $7F_{16}$ as full positive swing. Within each of these steps you can fine tune the bend by setting the first data byte to anything between 00_{16} and $7F_{16}$. To create normal Pitch Bend you would probably change the second byte, which means that the line should look like this: E0,00,XX.



Sys Ex

System Exclusive messages are the only MIDI messages that don't follow any specific standard. A System Exclusive message *may* contain a Channel number (or a similar value called a "device number") but this may be found anywhere within the message and Cubase VST is therefore not able to find it and replace it with the Channel number set at the top of the dialog box.

If it applies, you have to enter the right Channel number directly, somewhere into the message.

Sys Ex messages always start with $F0_{16}$, and after that comes a number which represents the manufacturer (Roland have 41_{16}, Yamaha 43_{16} and so on, but this *may* be more than one byte). After this comes (almost) anything that the manufacturer has decided makes sense for their products. The whole message always ends with a $F7_{16}$ (End Of Exclusive, EOX).

Sys Ex is mostly used for two things, sending out and receiving complete Programs (Patches, Timbres...) to and from a unit, and for changing individual parameters. You probably could make a MIDI Mixer Object ask a synthesizer to give away a copy of all the settings in all Programs or something like that, but it isn't really well suited for that. The System Exclusive messages you will send out from the MIDI Mixer window will probably be aimed at changing individual parameters.

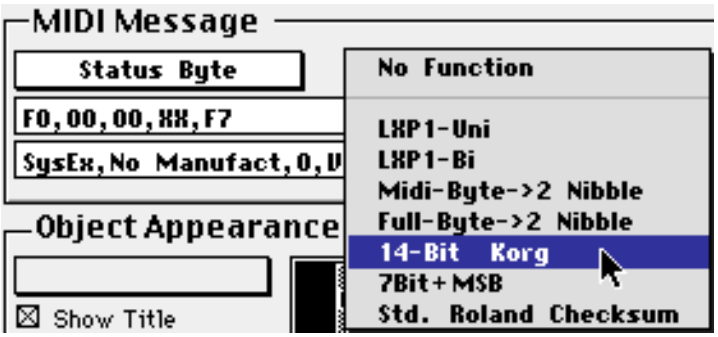
It is hard to say how these messages should be built up, but here is a model of a general one:

- The whole thing starts with $F0_{16}$ (beginning of System Exclusive), followed by the manufacturers code.
- After this often comes a Device Number, which is almost the same as a MIDI Channel number. It is used if you have two units of the same model and wish to be able to address them individually. This number is often set with a parameter on the unit called “Global MIDI Channel” or “Device Number”, “ID Number” or something like that.
- After this comes a number the manufacturer uses to identify the model (Ensoniq has one number for the EPS, one for the SQ-80, yet another for the VFX and so on).
- What we have described up to now is often called the “System Exclusive header”. After that comes a code telling that you want to access parameters, followed by a number telling exactly which parameter, and lastly a byte for the value of it (this is where your XX goes).
- And finally End of System Exclusive ($F7_{16}$). All in all a message of something between six and fifteen bytes.

To make this work, you must set the receiving unit to receive System Exclusive messages and make sure that any “Global MIDI Channel”, “Device Number” or “ID Number” is correct. Also save a copy of the programs in the unit before starting to experiment, since instruments have been known to misbehave when sent incorrectly formatted data.

Information on how to build up System Exclusive messages is often found in the back of the unit’s operation manual (in fine print!). Otherwise, it can always be requested from the manufacturer. Either way, it is no light reading!

The Extra Menu for System Exclusive Messages



The Extra menu works in a pretty special way for the System Exclusive messages. Due to MIDI's nature, you can't send data bytes with values higher than 127 ($7F_{16}$). Many parameters on synthesizers vary between larger numbers than that (for example -99 to +99) so Cubase VST has a few tricks up its sleeve (or rather up the Extra menu) to make an Object able to send the full range of values for that parameter although the Objects max and min values are always 0 and 127. Let's get technical:

Function	Description
No Function	The variable is not converted.
Lxp-Uni and Lxp-Bi	These two are for the Lexicon LXP-1. More information is found in the LXP-1 operation manual.
MIDI Byte -> 2 Nibble	A byte formed as a MIDI byte (0 to 127 only) is converted into two nibbles (four-bit packages) each sent out in the MIDI format.
Full Byte -> 2 Nibble	As above but the variable extrapolated to a full byte, i.e. a byte ranging from 0 to 255. This is then converted into two nibbles. The Ensoniq VFX uses this format.
14 Bit (Korg)	The variable is extrapolated to a 14 bit "bi-polar" (allowing + and – settings) value for use with the Korg M- and T-series synthesizers.
7Bit+MSB	The variable is extrapolated to a full byte (0 to 255) and the most significant bit is sent out with the first byte, and the rest of the value is sent out with the second byte. Oberheim uses this format with e.g. the Matrix synthesizers.

If you plan to use any of the data formats described above (except No Function of course), put the Variable (XX) in where the section of the Sys Ex message that changes with the Object *begins*. Then enter 00 as the next byte to make room for the extrapolated data as explained above. Then select one of the described types of conversion of the variable from the Extra menu.

Using Checksums

Some synths need a checksum for each Sys Ex message. If you select "Std Roland Checksum", from the Extra menu, a checksum is automatically sent out for Roland synthesizers.

Conversion Table

Decimal $_{10}$	Hexadecimal $_{16}$	Binary $_{2}$
0	0	0000 0000
1	1	0000 0001
2	2	0000 0010
3	3	0000 0011
4	4	0000 0100
5	5	0000 0101
6	6	0000 0110
7	7	0000 0111
8	8	0000 1000
9	9	0000 1001
10	A	0000 1010
11	B	0000 1011
12	C	0000 1100
13	D	0000 1101
14	E	0000 1110
15	F	0000 1111
16	10	0001 0000
17	11	0001 0001
18	12	0001 0010
19	13	0001 0011
20	14	0001 0100
21	15	0001 0101
22	16	0001 0110
23	17	0001 0111
24	18	0001 1000
25	19	0001 1001
26	1A	0001 1010
27	1B	0001 1011
28	1C	0001 1100
29	1D	0001 1101
30	1E	0001 1110
31	1F	0001 1111
32	20	0010 0000
33	21	0010 0001
34	22	0010 0010
35	23	0010 0011
36	24	0010 0100
37	25	0010 0101
38	26	0010 0110
39	27	0010 0111
40	28	0010 1000
41	29	0010 1001
42	2A	0010 1010
43	2B	0010 1011

Decimal $_{10}$	Hexadecimal $_{16}$	Binary $_{2}$
44	2C	0010 1100
45	2D	0010 1101
46	2E	0010 1110
47	2F	0010 1111
48	30	0011 0000
49	31	0011 0001
50	32	0011 0010
51	33	0011 0011
52	34	0011 0100
53	35	0011 0101
54	36	0011 0110
55	37	0011 0111
56	38	0011 1000
57	39	0011 1001
58	3A	0011 1010
59	3B	0011 1011
60	3C	0011 1100
61	3D	0011 1101
62	3E	0011 1110
63	3F	0011 1111
64	40	0100 0000
65	41	0100 0001
66	42	0100 0010
67	43	0100 0011
68	44	0100 0100
69	45	0100 0101
70	46	0100 0110
71	47	0100 0111
72	48	0100 1000
73	49	0100 1001
74	4A	0100 1010
75	4B	0100 1011
76	4C	0100 1100
77	4D	0100 1101
78	4E	0100 1110
79	4F	0100 1111
80	50	0101 0000
81	51	0101 0001
82	52	0101 0010
83	53	0101 0011
84	54	0101 0100
85	55	0101 0101
86	56	0101 0110
87	57	0101 0111

Decimal $_{10}$	Hexadecimal $_{16}$	Binary $_{2}$
88	58	0101 1000
89	59	0101 1001
90	5A	0101 1010
91	5B	0101 1011
92	5C	0101 1100
93	5D	0101 1101
94	5E	0101 1110
95	5F	0101 1111
96	60	0110 0000
97	61	0110 0001
98	62	0110 0010
99	63	0110 0011
100	64	0110 0100
101	65	0110 0101
102	66	0110 0110
103	67	0110 0111
104	68	0110 1000
105	69	0110 1001
106	6A	0110 1010
107	6B	0110 1011
108	6C	0110 1100
109	6D	0110 1101
110	6E	0110 1110
111	6F	0110 1111
112	70	0111 0000
113	71	0111 0001
114	72	0111 0010
115	73	0111 0011
116	74	0111 0100
117	75	0111 0101
118	76	0111 0110
119	77	0111 0111
120	78	0111 1000
121	79	0111 1001
122	7A	0111 1010
123	7B	0111 1011
124	7C	0111 1100
125	7D	0111 1101
126	7E	0111 1110
127	7F	0111 1111