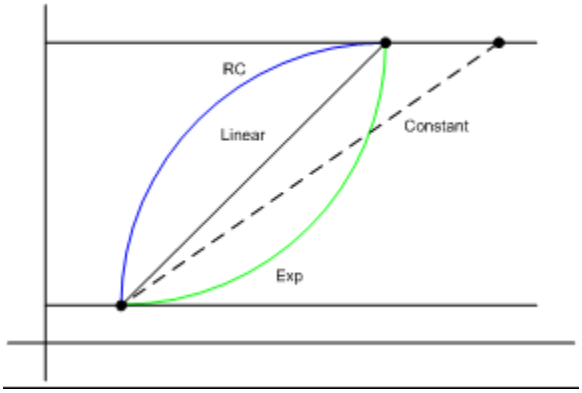
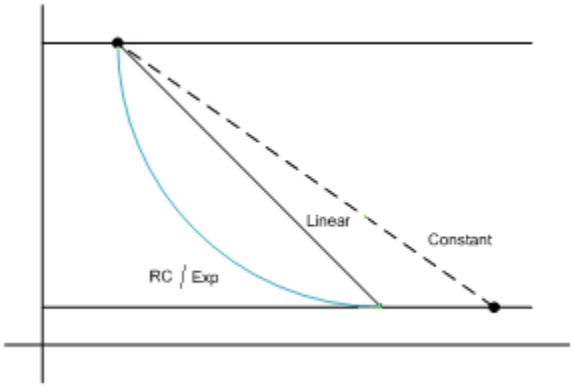
SLEW HARDWARE

TARGET/SLEW ACCELERATOR

The target/slew accelerator contains 4 separate target/slew math units, each of which can be set to auto-ramp from one value to a desired final value in one of four modes.



Up modes



Down modes

Summary

The DSP core has a memory mapped target/slew accelerator block. The four target/slew accelerators can be used for volume controls or smooth cross-fading effects, but may be used to update any value input into the target/current registers.

Each of the four math units is linked to its own register, denominated by 0 to 3. Before using a math unit, it is important to configure its associated mode register. Using a math unit to calculate a new value is achieved by (1) writing the target value into the intended math unit's target register, then (2) writing the current value into the current register. For proper operation of the math unit, the target register must be updated before the current register. The math unit takes one cycle to calculate the value, after which the result can be read from the next register.

31:16	15:10	9:4	3:2	1:0
0000000000000000	Time_Constant_Up[5:0]	Time_Constant_Down[5:0]	Curve_Type_Up[1:0]	Curve_Type_Down [1:0]

Table 1. Slew mode register

1:0	Type
0	Linear
1	Constant dB
2	RC type
3	Constant time

Table 2. Curve_Type_Up and Curve_Type_Down

Ramp Type: Linear

Linear math is the addition or subtraction of a constant value (step). The equation to describe this step size is:

$$step = \frac{2^{15}}{10^{\frac{2\times(\text{tc[3:0]-5})}{20}}}$$

The result of the equation is normalized to 8.24 data format. This gives a time constant range from 6.75 ms to 213.4 ms (–60 dB relative to 0 dB full scale). An example of this kind of update is shown in Figure 1.

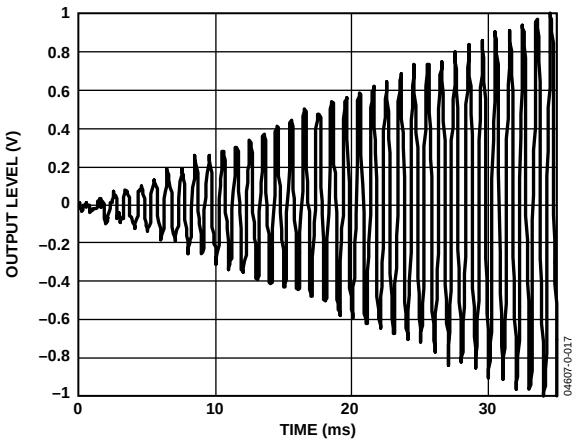


Figure 1. Slew RAM—Linear Update Plot

Ramp Type: Constant dB and RC Type (Exponential)

Exponential math is accomplished by shifts and adds with a range from 2.1 ms to 54 s (–60 dB relative to 0 dB full scale). When the ramp type is set to 01 (constant dB), each step size is set to the current value in the slew data. When the ramp type bits are set to 10 (RC type), the step sizes are equal to the difference between the values in the target register and the current register. Figure 2 and Figure 3 show examples of this type of target/slew HW ramping. A decreasing ramp of both the constant dB and RC type ramps is a mirror image of the constant dB increasing ramp. Note: Smallest step size is 2^{-24}.

Constant dB

$$step = current + (current \gg tc[5:2]) + \Big((current \gg tc[5:2]) \gg \big((tc[1:0] + 1)\%4\big)\Big)$$

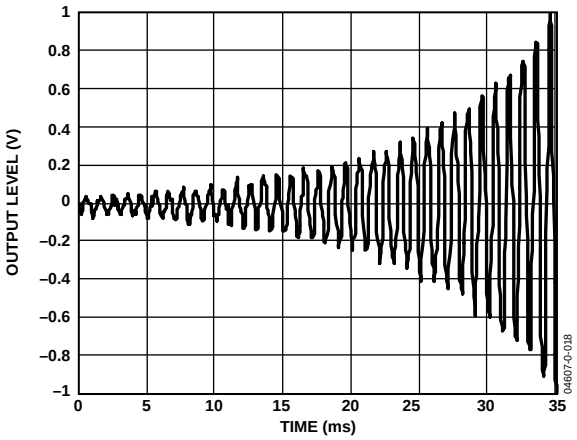


Figure 1. Slew RAM—Constant dB Update Plot

RC Type

$$diff = target - current$$
$$step = diff + (diff \gg tc[5:2]) + \Big((diff \gg tc[5:2]) \gg \big((tc[1:0] + 1)\%4\big)\Big)$$

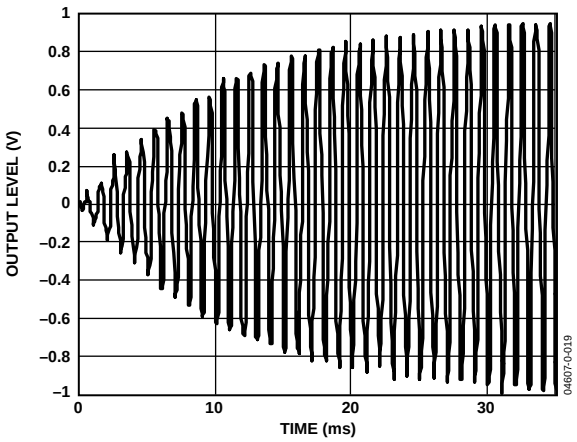


Figure 2. Slew RAM—RC-Type Update Plot

The equations above describe how the next value is calculated relative to the value of the current sample. Therefore, the effective time constant scales in proportion to the sample rate. For example, if the time between samples is halved (i.e. the sample rate is doubled), then the time to reach the target will halve and the slew rate will double. The slew rates in absolute time are shown in Table 3 at a sample rate of 48 kHz.

Approximate Delay Values (RC/Constant dB)

Time_Constant (tc)	Target slew times	Achieved slew times
NA	Instant	NA
0		2.083 ms
1		2.521 ms
2		2.813 ms
3		3.167 ms
4		4.25 ms
5		5.083 ms
6		5.646 ms
7		6.333 ms
8		8.375 ms
9	10 ms	10.021 ms
10		11.083 ms
11		12.396 ms
12		16.375 ms
13	20 ms	19.479 ms
14		21.542 ms
15		24.104 ms
16	30 ms	31.688 ms
17		37.667 ms
18	40 ms	41.646 ms
19	50 ms	46.542 ms
20	60 ms	61.104 ms
21	70 ms	72.563 ms

22	80 ms	80.167 ms
23	90 ms	89.562 ms
24	100 ms	117.437 ms
25		139.417 ms
26		153.917 ms
27		171.917 ms
28	200 ms	225.208 ms
29		267.167 ms
30	300 ms	294.875 ms
31		329.229 ms
32	400 ms	430.833 ms
33	500 ms	510.883 ms
34		563.604 ms
35	600 ms,700 ms	629.062 ms
36	800 ms,900 ms	822.438 ms
37	1000 ms	974.5 ms
38		1075 ms
39		1199 ms
40		1566 ms
41		1855 ms
42	2000 ms	2045 ms
43		2280 ms
44	3000 ms	2975 ms
45		3520 ms
46	4000 ms	3879 ms
47		4324 ms
48	5000 ms	5634 ms
49		6661 ms
50		7338 ms
51		8174 ms
52		10637 ms
53		12566 ms
54		13834 ms
55		15403 ms
56		20013 ms
57		23617 ms
58		25986 ms
59		28912 ms
60		27502 ms
61		44206 ms
62		48607 ms
63		54039 ms

Table 3. Time Constant Values

Ramp Type: Constant Time

Constant time math is accomplished by adding a step value that is calculated after each new target is loaded. The equation for this step size is

step = (Target - Current) / (Number of steps)

Figure 4 shows a plot of the target/slew RAM operating in constant time mode. For this example, 128 steps are used to reach the target value. This type of ramping takes a fixed amount of time for a given number of steps, regardless of the difference in the initial state and the target value. Figure 5 shows a plot of a constant time ramp from –80 dB to –6 dB (half scale) using 128 steps. You can see that the ramp takes the same amount of time as the previous ramp from –80 dB to 0 dB. A constant time decreasing ramp is a mirror image of the increasing ramp.

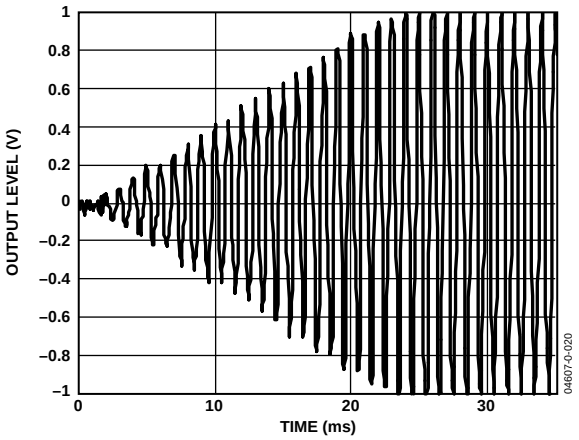


Figure 4 Slew RAM— Constant Time Update Plot, Full Scale

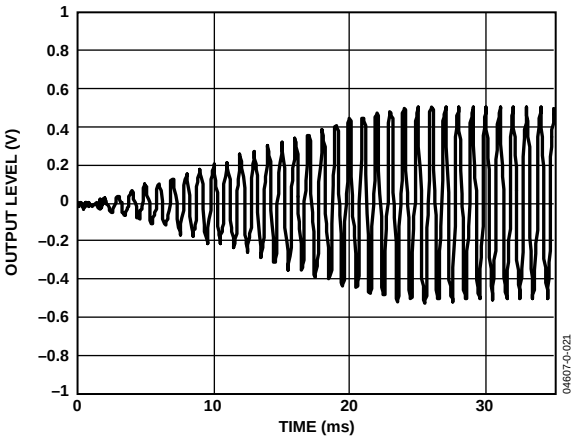
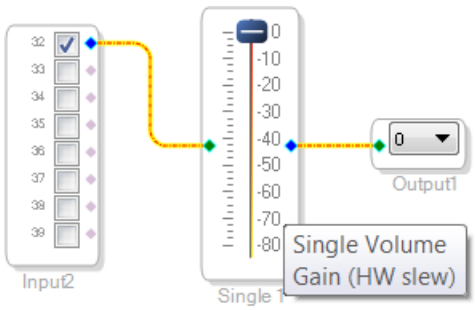


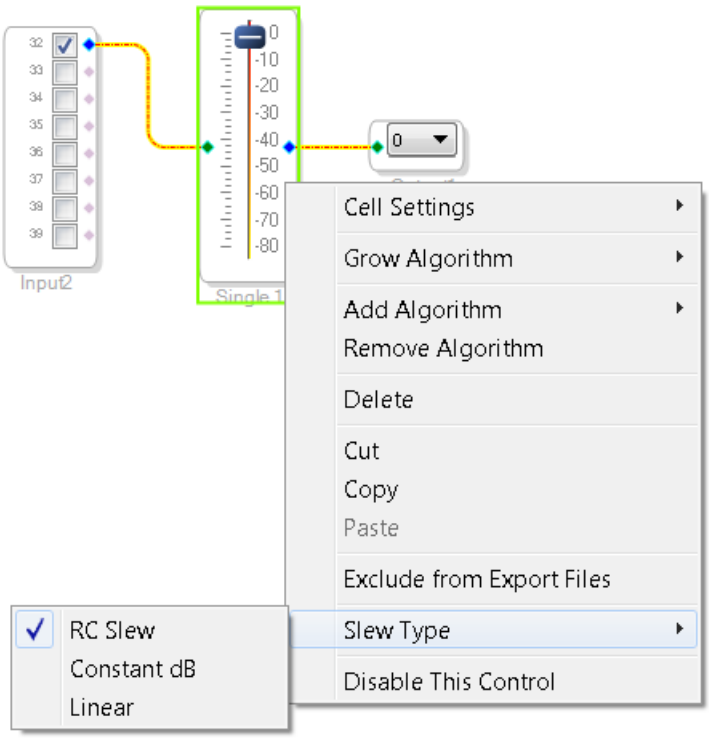
Figure 5 Slew RAM— Constant Time Update Plot, Half Scale

SigmaStudio

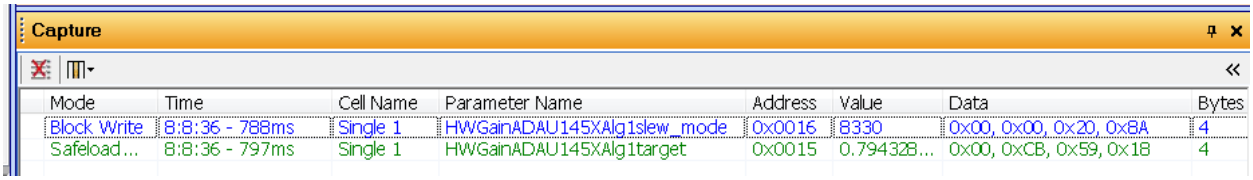
The hardware slew accelerator is used in many of the standard blocks within SigmaStudio. An example is the Single Volume Gain block shown below.



The shape of the hardware slew curve is selectable by right-clicking on the block.



When the volume slider is moved, SigmaStudio writes the corresponding update to the hardware slew registers to calculate a smooth change in gain. This update can be viewed in the Capture Window. A volume change in the schematic above shows the following write:



The hex value 0x0000208A has been written to the hardware slew register, and 0x00CB5918 has been written to the target register. Referencing Table 1 and Table 2, this corresponds to:

Curve type down = 10 = RC Type

Curve type up = 10 = RC Type

Time constant down = 001000 = 8

Time constant up = 001000 = 8

In this example, the slew shape is RC type, and the volume slew rate, as show in Table 3, corresponds to the equivalent time constant of 8.375 ms over a 60dB range.