# Expert Sleepers Disting Quick Reference

| | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|
| a | Precision Adder | Linear/Exponential Converter | Sample and Hold | LFO |
| b | Four Quadrant Multiplier | Quantizer | Slew Rate Limiter | Clockable LFO |
| c | Full-wave Rectifier | Comparator | Pitch and Envelope Tracker | VCO with linear FM |
| d | Minimum/maximum | Dual Waveshaper | Clockable Delay/Echo | VCO with waveshaping |

### 1-a Precision Adder

A = X + Y + offset
B = X - Y - offset
offset = ±10V in 1V steps derived from Z

### 1-b Four Quadrant Multiplier

A = X * Y * scale
B = -X * Y * scale
scale = 1/10 to 10x in steps derived from Z

| | Scale | 1x | 2x | 3x | 4x | 5x | 6x | 7x | 8x | 9x | 10x |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LED 3 unlit | LED a | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - |
| | LED b | - | 0 | 0 | - | - | 0 | 0 | - | - | 0 |
| | LED c | - | - | - | 0 | 0 | 0 | 0 | - | - | - |
| | LED d | - | - | - | - | - | - | - | 0 | 0 | 0 |
| LED 3 lit | Scale | | /2 | /3 | /4 | /5 | /6 | /7 | /8 | /9 | /10 |
| | LED a | | - | 0 | - | 0 | - | 0 | - | 0 | - |
| | LED b | | 0 | 0 | - | - | 0 | 0 | - | - | 0 |
| | LED c | | - | - | 0 | 0 | 0 | 0 | - | - | - |
| | LED d | | - | - | - | - | - | - | 0 | 0 | 0 |

### 1-c Full-wave Rectifier

A = abs( X + Y ) or abs( X )
B = abs( X - Y ) or abs( Y )
Z selects mode

### 1-d Minimum/maximum

A = min( X, Y )
B = max( X, Y )
Z is gate

### 2-a Linear/Exponential Converter

A = ( 2 ^ X ) * scale
B = log2( Y / scale )
Z is Hz/V scale, centered on 1kHz

### 2-b Quantizer

A = quantized( X )
B = trigger on note change
Z chooses scale & function of Y
Y = transpose (Z positive) or trigger (Z negative)

| Scale | chromatic | major scale | minor scale | major triad | minor triad | root +5th | major triad +6th | minor triad +6th | major triad +7th | minor triad +7th | root +5th +6th | root +5th +7th | pentatonic major | pentatonic minor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LED a | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 |
| LED b | - | - | 0 | 0 | - | - | 0 | 0 | - | - | 0 | 0 | - | - |
| LED c | - | - | - | - | 0 | 0 | 0 | 0 | - | - | - | - | 0 | 0 |
| LED d | - | - | - | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |

### 2-c Comparator

A = gate from X > Y
B = inverted gate
Z is hysteresis

### 2-d Dual Waveshaper

A = folded X
B = triangle-to-sine Y
Z is gain

### 3-a Sample and Hold

A = X when Y exceeds 1V
B = noise ±8V
Z is slew rate

### 3-b Slew Rate Limiter

A = linear slew rate limited ( X + Y )
B = log slew rate limited ( X + Y )
Z is slew rate

### 3-c Pitch and Envelope Tracker

A = V/octave pitch derived from X, plus Y
B = envelope dervied from X
Z is slew rate for envelope

### 3-d Clockable Delay/Echo

X is signal
Y is clock input
Z is feedback
A = dry + delay in ratio according to feedback
B = delay signal only

### 4-a LFO

X is Hz/V frequency
Y is waveshape
Z is tune
A is saw -> sine -> triangle
B is pulse -> square -> pulse

| Input Y | -10V | 0V | +10V |
|---|---|---|---|
| Output A | saw | sine | triangle |
| Output B | 0% duty cycle pulse | 50% duty cycle pulse (square) | 100% duty cycle pulse |

### 4-b Clockable LFO

X is clock input
Y is waveshape
Z is integer multiplier/divider
A is saw -> sine -> triangle
B is pulse -> square -> pulse

| Input Y | -10V | 0V | +10V |
|---|---|---|---|
| Output A | saw | sine | triangle |
| Output B | 0% duty cycle pulse | 50% duty cycle pulse (square) | 100% duty cycle pulse |

| | Frequency | 1x | 2x | 3x | 4x | 5x | 6x | 7x | 8x | 9x | 10x | 11x | 12x | 13x | 14x | 15x | 16x |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LED 3 unlit | LED a | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - |
| | LED b | - | 0 | 0 | - | - | 0 | 0 | - | - | 0 | 0 | - | - | 0 | 0 | - |
| | LED c | - | - | - | 0 | 0 | 0 | 0 | - | - | - | - | 0 | 0 | 0 | 0 | - |
| | LED d | - | - | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| | LED 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| LED 3 lit | Frequency | | /2 | /3 | /4 | /5 | /6 | /7 | /8 | /9 | /10 | /11 | /12 | /13 | /14 | /15 | /16 |
| | LED a | | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - |
| | LED b | | 0 | 0 | - | - | 0 | 0 | - | - | 0 | 0 | - | - | 0 | 0 | - |
| | LED c | | - | - | 0 | 0 | 0 | 0 | - | - | - | - | 0 | 0 | 0 | 0 | - |
| | LED d | | - | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| | LED 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |

### 4-c VCO with linear FM

X is V/Oct pitch input
Y is linear FM input
Z is tune ±0.5 octaves
A is sine
B is saw

### 4-d VCO with waveshaping

X is V/Oct pitch input
Y is waveshape/PWM
Z is tune ±0.5 octaves
A is saw -> tri -> saw
B is pulse -> square -> pulse

| Input Y | -10V | 0V | +10V |
|---|---|---|---|
| Output A | saw (falling) | triangle | saw (rising) |
| Output B | 0% duty cycle pulse | 50% duty cycle pulse (square) | 100% duty cycle pulse |