

```

+                               out_high = 5.0)

```

12.2.22 Controlled Triangle Wave Oscillator

```

NAME_TABLE:
C_Function_Name:    cm_triangle
Spice_Model_Name:   triangle
Description:        "controlled triangle wave oscillator"
PORT_TABLE:
Port Name:          cntl_in                out
Description:        "control input"        "output"
Direction:          in                    out
Default_Type:       v                      v
Allowed_Types:      [v,vd,i,id]           [v,vd,i,id]
Vector:             no                    no
Vector_Bounds:      -                      -
Null_Allowed:       no                    no
PARAMETER_TABLE:
Parameter_Name:     cntl_array             freq_array
Description:        "control array"        "frequency array"
Data_Type:          real                   real
Default_Value:      0.0                   1.0e3
Limits:             -                     [0 -]
Vector:             yes                   yes
Vector_Bounds:      [2 -]                 cntl_array
Null_Allowed:       no                    no
PARAMETER_TABLE:
Parameter_Name:     out_low                out_high
Description:        "output peak low value" "output peak high value"
Data_Type:          real                   real
Default_Value:      -1.0                  1.0
Limits:             -                     -
Vector:             no                    no
Vector_Bounds:      -                     -
Null_Allowed:       yes                   yes
PARAMETER_TABLE:
Parameter_Name:     duty_cycle
Description:        "rise time duty cycle"
Data_Type:          real
Default_Value:      0.5
Limits:             [1e-10 0.999999999]
Vector:             no
Vector_Bounds:      -
Null_Allowed:       yes

```

Description: This function is a controlled triangle/ramp wave oscillator with parametrizable values of low and high peak output and rise time duty cycle. It takes an input voltage or current value. This value is used as the independent variable in the

piecewise linear curve described by the coordinate points of the `cntl_array` and `freq_array` pairs.

From the curve, a frequency value is determined, and the oscillator will output a triangle wave at that frequency. From the above, it is easy to see that array sizes of 2 for both the `cntl_array` and the `freq_array` will yield a linear variation of the frequency with respect to the control input. Any sizes greater than 2 will yield a piecewise linear transfer characteristic. For more detail, refer to the description of the piecewise linear controlled source, which uses a similar method to derive an output value given a control input.

Example SPICE Usage:

```
ain 1 2 ramp1
.model ramp1 triangle(cntl_array = [-1 0 5 6]
+                      freq_array=[10 10 1000 1000] out_low = -5.0
+                      out_high = 5.0 duty_cycle = 0.9)
```