
Qspice KSKelvin Symbol Explanation

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Ideal Opamp

Qspice : Opamp_Ideal.qsym

Ideal Operation Amplifier - Overview

Qspice : ComptrOD_Ideal.qsym

- Ideal Opamp Sub-Circuit
 - opamp.sub in LTspice library

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```
.subckt opamp 1 2 3
```

```
G1 0 3 2 1 {Aol}
```

```
R3 3 0 1.
```

```
C3 3 0 {Aol/GBW/6.28318530717959}
```

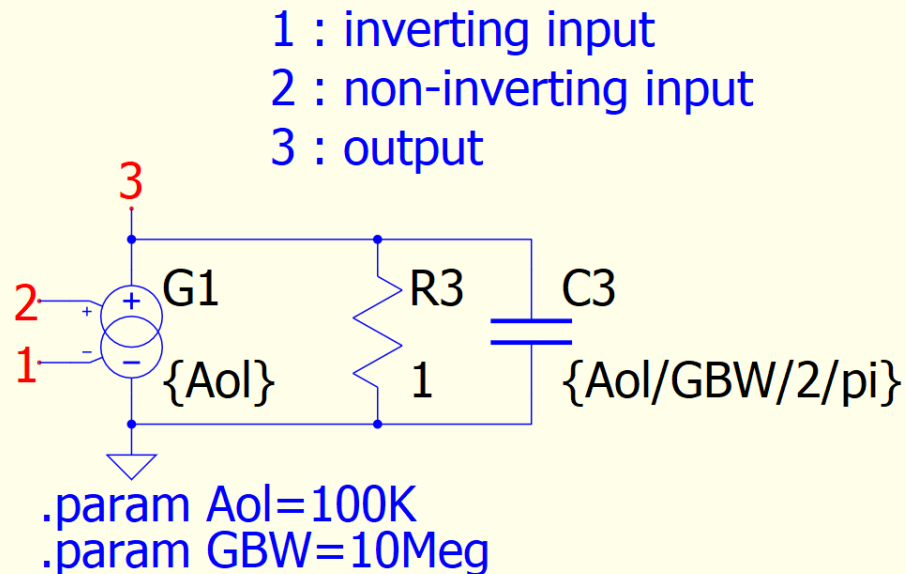
```
.ends opamp
```

- Opamp equivalent formula

$$V_{output} = Z(R_3, C_3) \times Aol \times I_{G1}$$

$$V_{output} = (R_3 // \frac{1}{j\omega C_3}) \times Aol \times (V_p - V_n)$$

Opamp.sub Equivalent Schematic



Ideal Operation Amplifier – Parameters of Symbol

Qspice : ComptrOD_Ideal.qsym

Method #1

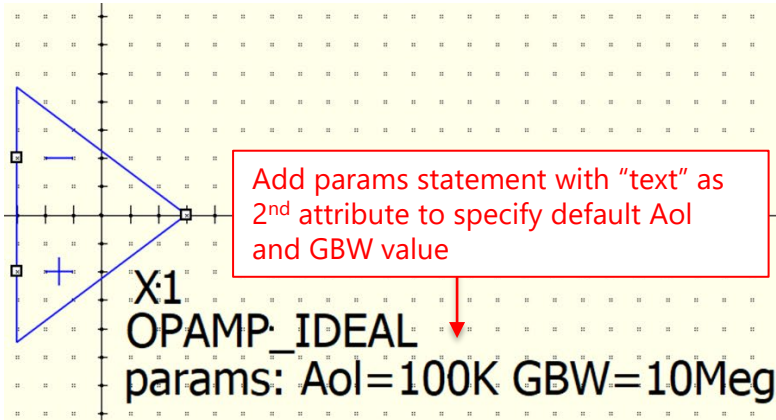


Diagram of an ideal op-amp symbol (X1) with parameters: **OPAMP_IDEAL** and **params: Aol=100K GBW=10Meg**. A red box highlights the text "Add params statement with 'text' as 2nd attribute to specify default Aol and GBW value".

Symbol Properties

Application	
[Icons]	
Basics	
Symbol Type	X
Description	Ideal Opamp
Allow Shorted Pins	False
Library File	.subckt opamp_ideal 1 2 3 nG1 ...
String Attributes	
Text Order	Invis. Content
Name:	X1
1st attribute	OPAMP_IDEAL
2nd attribute	params: Aol=100K GBW=10Meg
Pin Nets	
Pin Name	Invis. Net
1	
2	
3	

Right click on 2nd attribute and make parameters attribute invisible in symbol if needs

Method #2

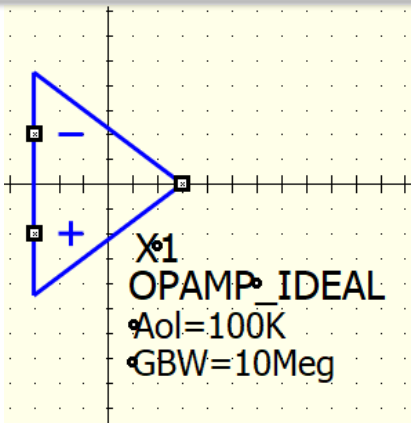


Diagram of an ideal op-amp symbol (X1) with parameters: **OPAMP_IDEAL** and **Aol=100K GBW=10Meg**.

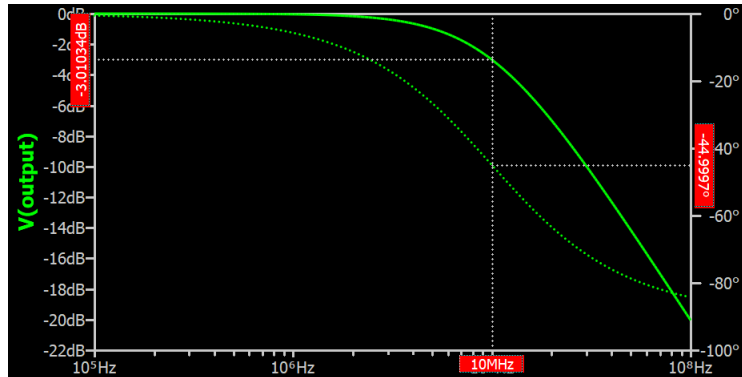
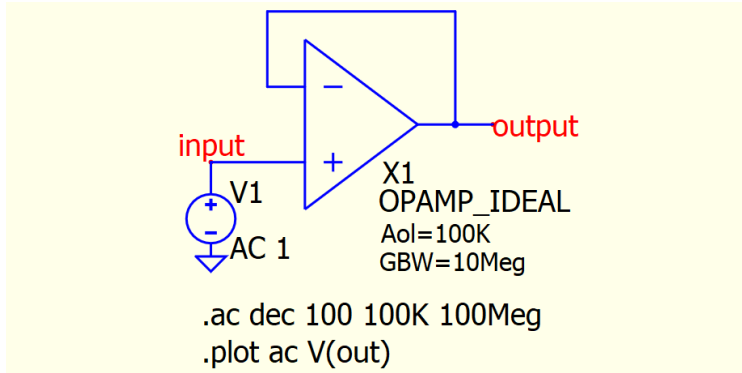
Symbol Properties

Application	
[Icons]	
Basics	
Symbol Type	X
Description	Ideal Opamp
Allow Shorted Pins	False
Library File	.subckt opamp_ideal 1 2 3 nG1 0 3 2 1
String Attributes	
Text Order	Invis. Content
Name:	X1
1st attribute	OPAMP_IDEAL
2nd attribute	Aol=100K
3rd attribute	GBW=10Meg

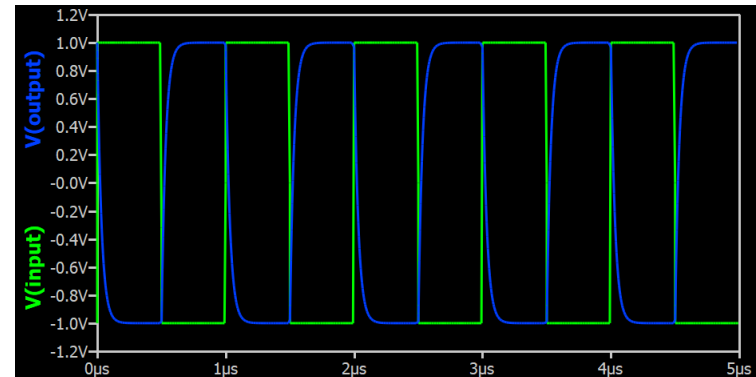
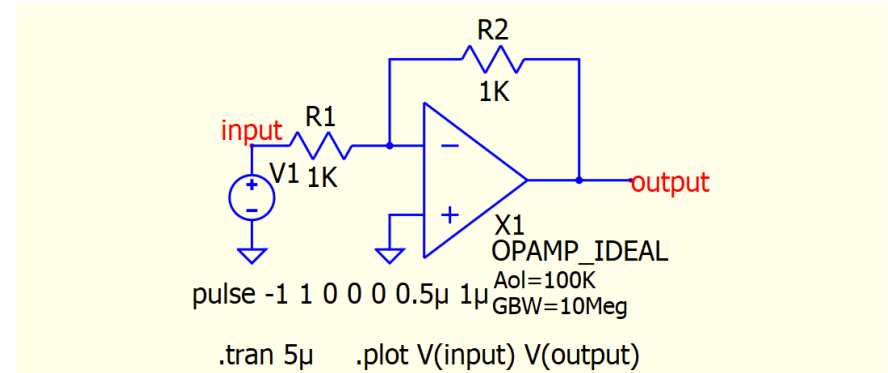
Add text for extra attribute Aol and GBW

Ideal Operation Amplifier - Simulation Example

Parent - opamp_ideal (.ac).qsch



Parent - opamp_ideal (.tran).qsch



Ideal Comparator

Qspice : Compr_Ideal.qsym

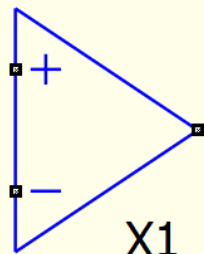
Qspice : ComprOD_Ideal.qsym

Qspice : Compr_Ideal_Supply.qsym

3 type of Ideal Comparators Overview

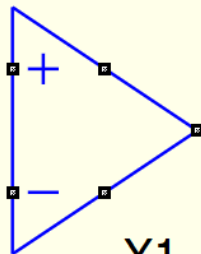
Qspice : Comptr_Ideal.qsym / Comptr_Ideal_Supply.qsym / ComptrOD_Ideal.qsym

Ideal Comparator (Output 0/1)
Comptr_Ideal.qsym



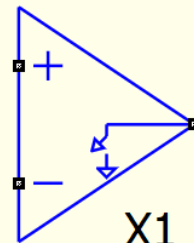
X1
COMPTR_IDEAL

Ideal Comparator (Vdd/Vss)
Comptr_Ideal_Supply.qsym

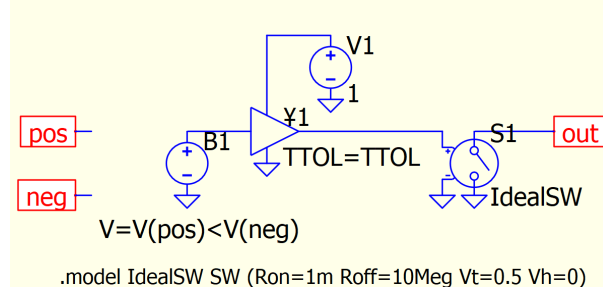
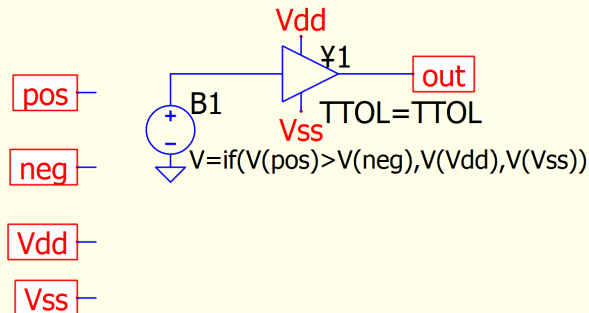
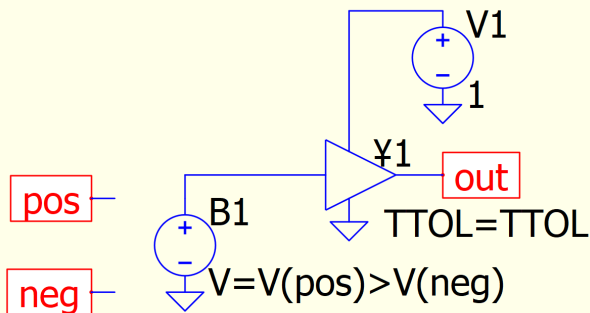


X1
COMPTR_IDEAL_Supply

Ideal Comparator (Open Drain)
ComptrOD_Ideal.qsym

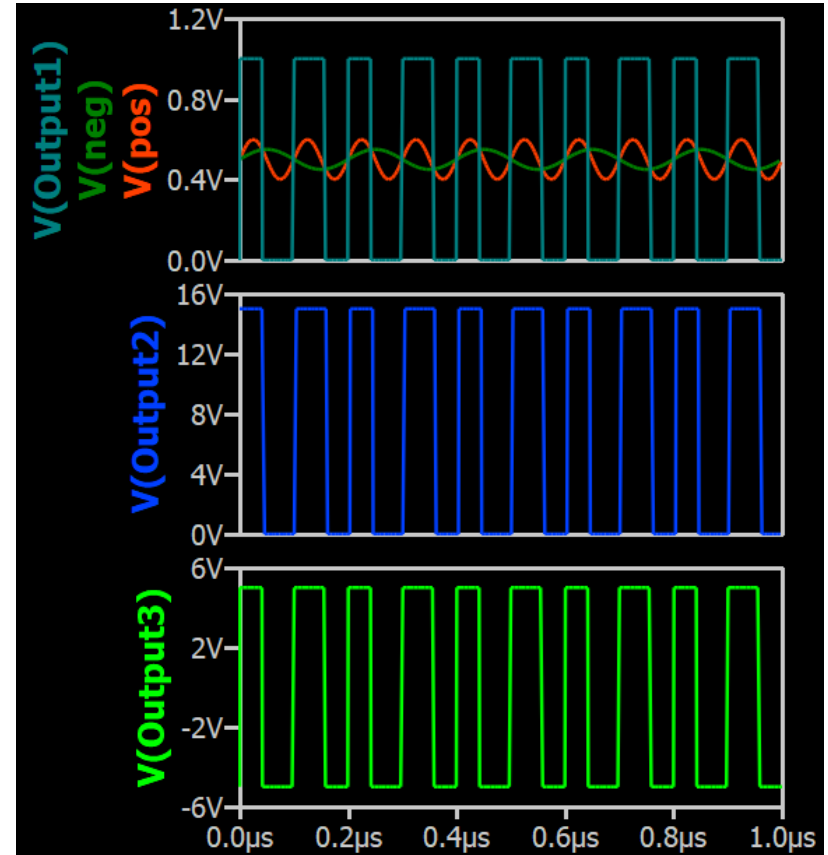
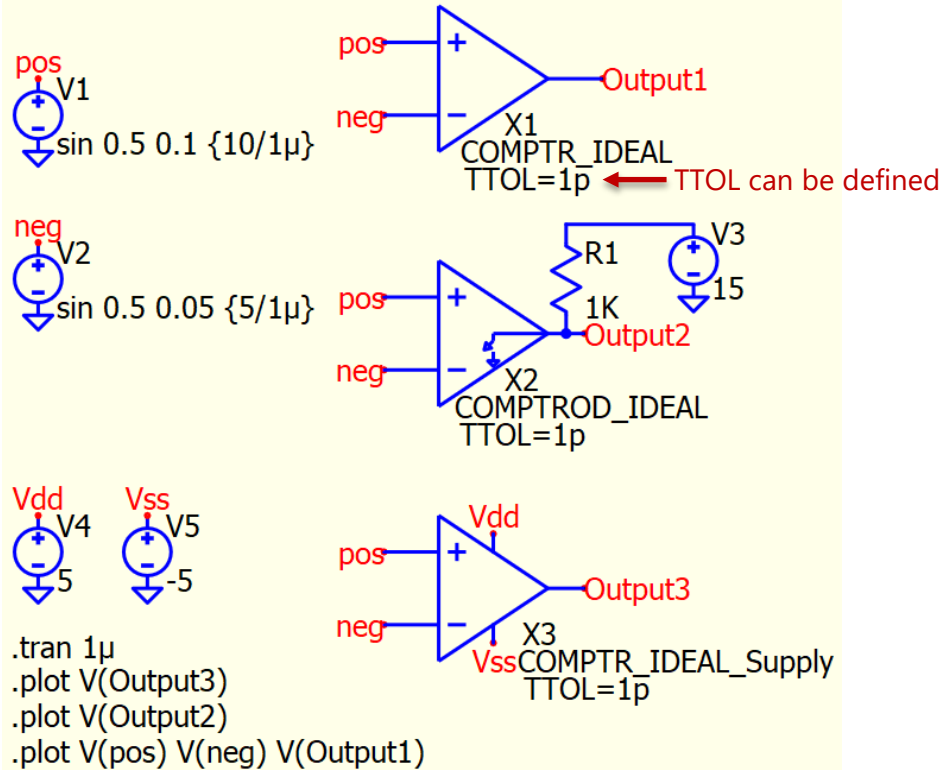


X1
COMPTROD_IDEAL



3 type of Ideal Comparators – Simulation Results

Qspice : Parent - Comparator.qsch



Control System

Gain, Different, PID and Signal Limiter

Qspice : Gain.qsym

Qspice : Different.qsym

Qspice : PID.qsym

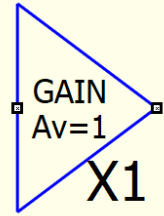
Qspice : Signal_Limiter.qsym

Gain and Different

Qspice : Gain.qsym / Difference.qsym

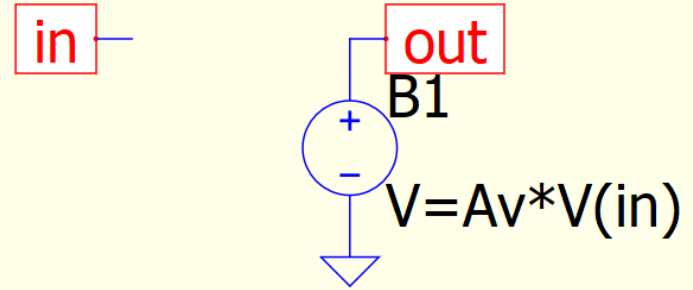
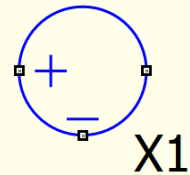
- Gain

- $V_{out} = A_v \times V_{input}$

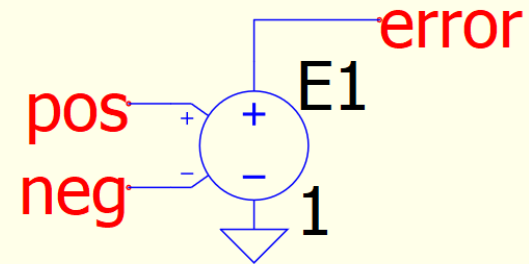


- Difference

- $V_{out} = V_+ - V_-$



.param Av=1

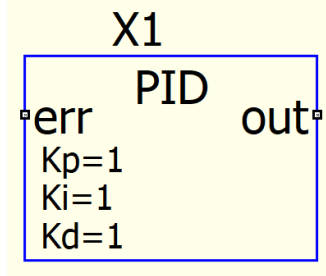


PID Controller and Signal Limiter

Qspice : PID.qsym / Signal_Limiter.qsym

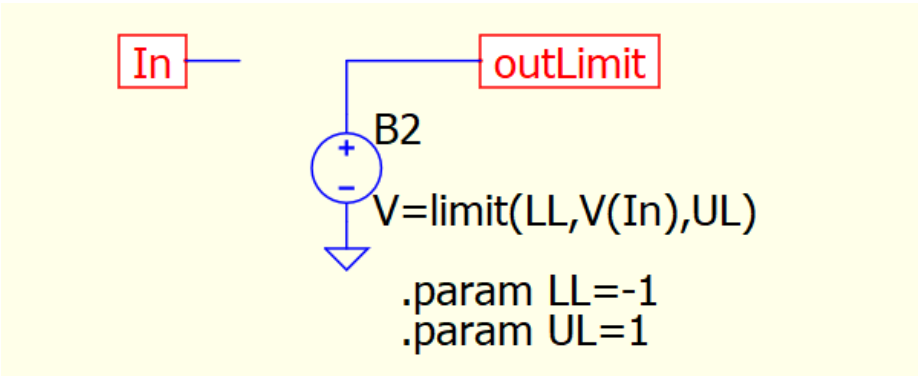
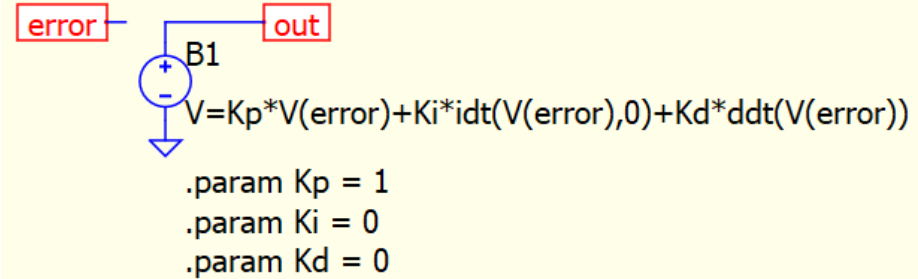
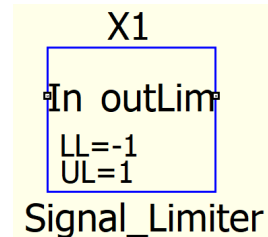
- PID Controller

- $$V_{out} = K_p V_{error} + K_i \int V_{error} dt + K_d \frac{dV_{error}}{dt}$$



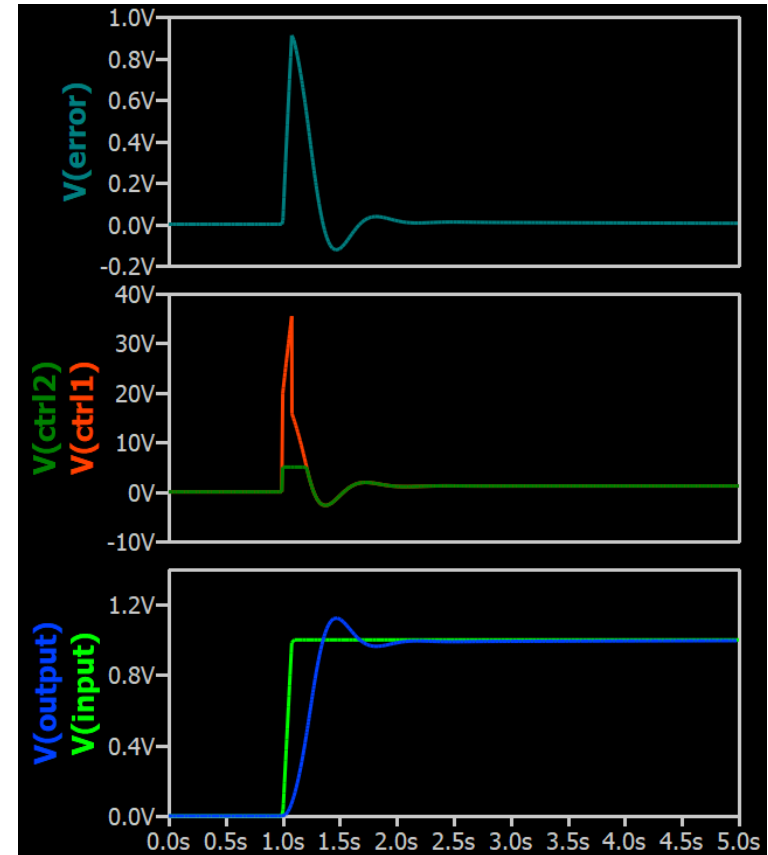
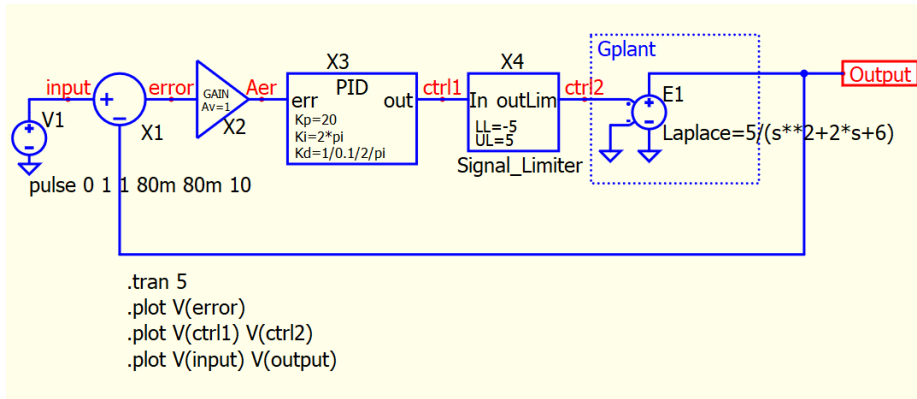
- Signal Limiter

- limit(x,y,z) | intermediate value of x, y, and z, equivalent to min(max(x,y),z)



Control System Symbol : Transient Simulation Example

Parent - PID CloseLoop (.tran).qsch



General Purpose

Delay

Qspice : Delay.qsym

- Delay

- Reason for Implementation

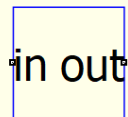
- Qspice B-source not offers delay function before 09/22/2023, but after that, Mike Engelhardt implemented delay(input,time) for arbitrary behavioral sources.

- Concept of Design

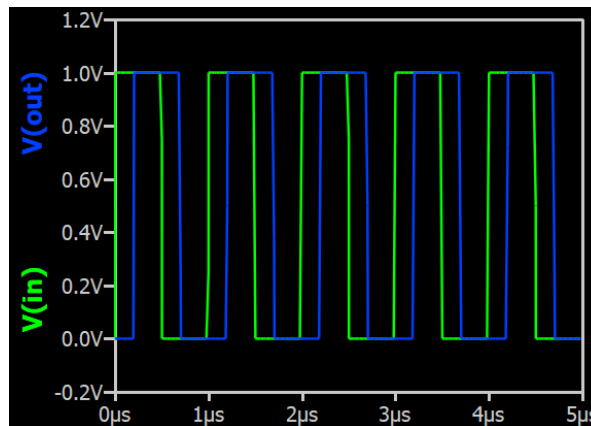
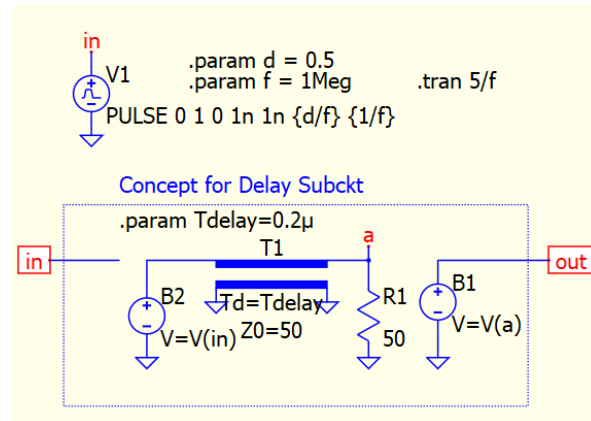
- T1 : T_d (delay) in ideal transmission line determines signal delay time
 - R1 : To prevent signal reflection, transmission line must terminate with Z_0
 - B1 : To prevent loading effect when using delay block

- Symbol of delay.qsym

X1



Tdelay=1m

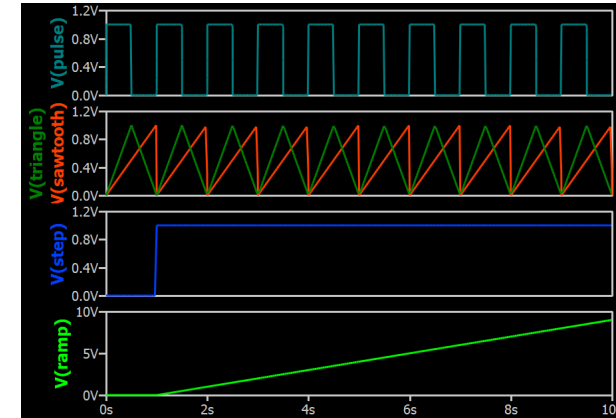
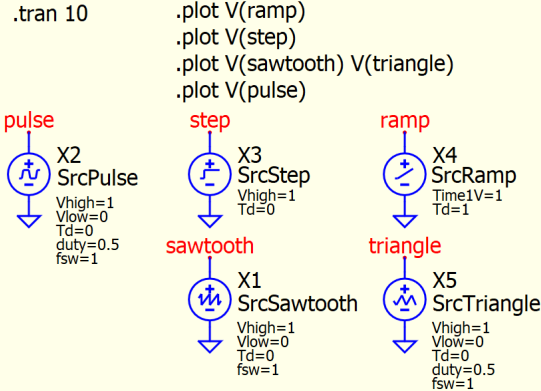


SrcXXX Special Voltage Source and Potentiometer

Qspice : Scrxxx.qsym / Potentiometer.qsym

• SrcXXX

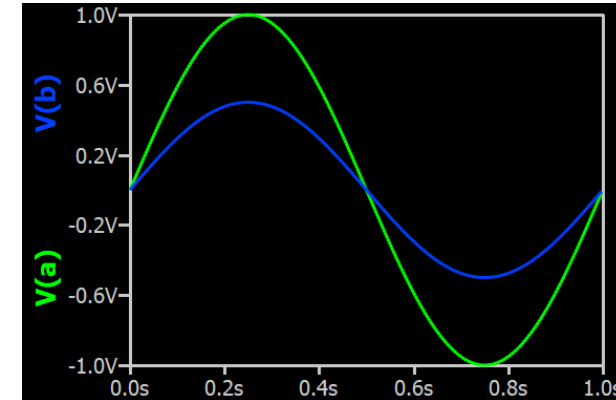
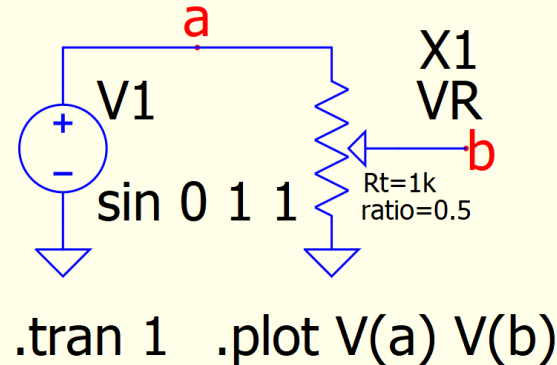
- SrcPulse.qsym
- SrcSawtooth.qsym
- SrcTriangle.qsym
- SrcStep.qsym
- SrcRamp.qsym



• Potentiometer

- Symbol : Potentiometer.qsym
- Ratio is limited to [1m,0.999]
- Sub-circuit script

```
.subckt VR + - m params: Rt=1k ratio=0.5  
.param w = limit(1m,ratio,0.999)  
R1 + m (1-w)*Rt  
R2 m - (w)*Rt  
.ends VR
```



Special Subckt

Voltage Control Current Source with Current Limit

Qspice : VCCS_Ilimit.qsym

- VCCS_Ilimit

- Use Behavioral source with $\text{limit}(x,y,z)$ function

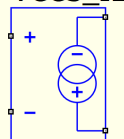
- Intermediate value of x , y , and z

- Sub-circuit

```
.subckt VCCS_Ilimit v+ v- out+ out-  
B1 out- out+ I=limit(gm*(V(v+)-V(v-)),Imax,Imin)  
.ends VCCS_Ilimit
```

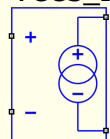
- Symbols

X1
VCCS_ILIMIT1



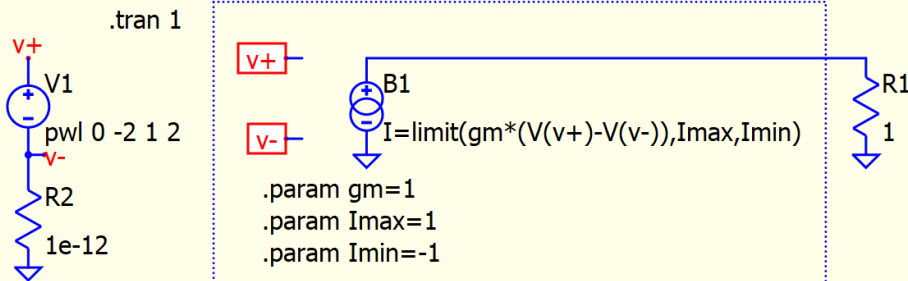
gm=1
Imin=-1
Imax=1

X2
VCCS_ILIMIT2

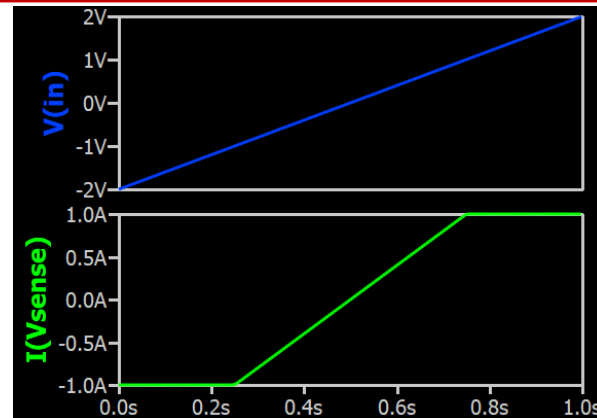
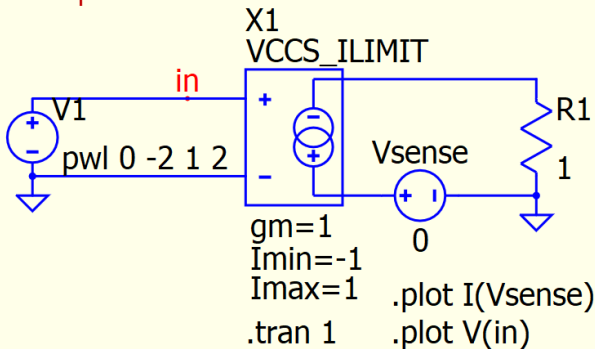


gm=1
Imin=-1
Imax=1

Idea of VVCS with Current Limit



Example

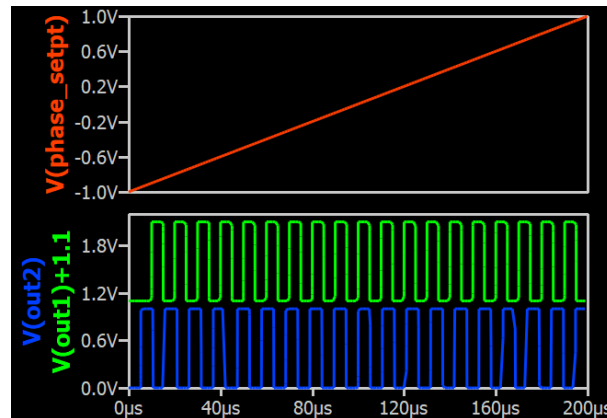
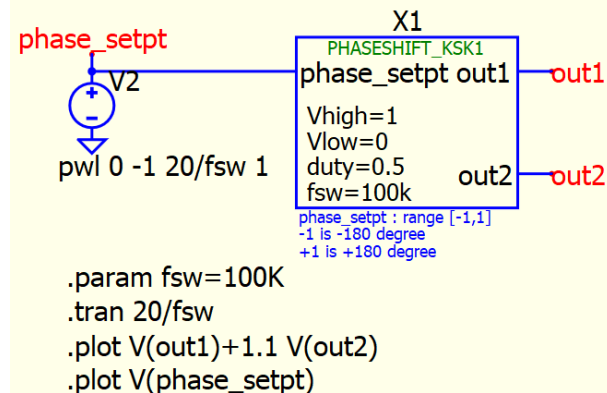
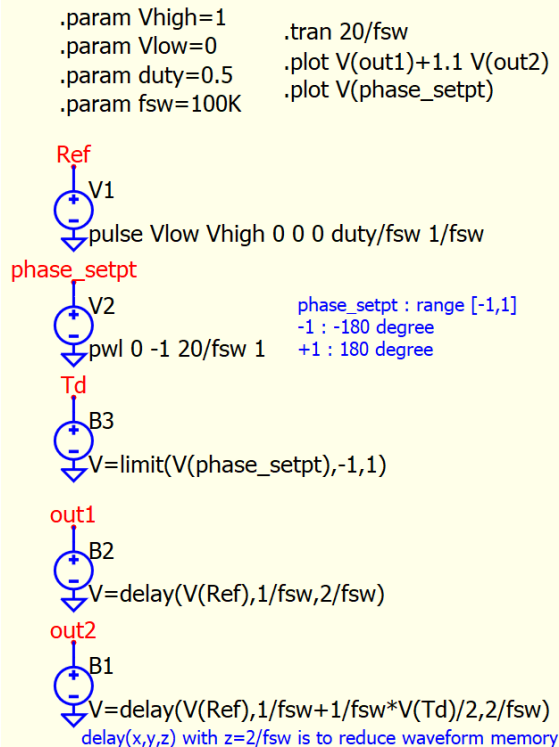


Phase Shift Pulse with Delay Control

Qspice : PhaseShift_KSK1.qsym

- PhaseShift_KSK1.qsym
 - Use behavioral source with delay function to generate phase controlled pulse source
 - User to define switching frequency and duty as input parameters (these cannot be change during simulation)
 - Phase_setpt is input port which control delay time in delay(), the delay is controlled with formula $\frac{v_{phase_setpt}}{2f_{sw}}$
 - A $\frac{1}{f_{sw}}$ is used to prevent negative y value into delay(x,y,z)
 - z set to $2f_{sw}$ to reduce waveform memory in simulation

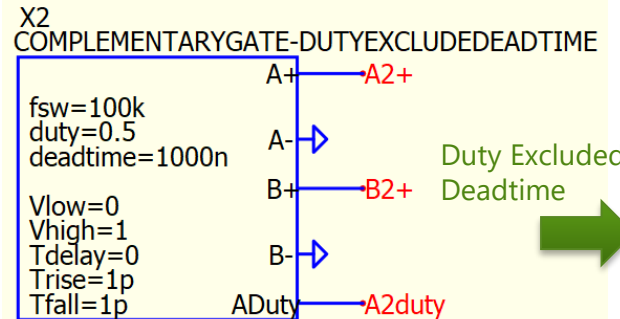
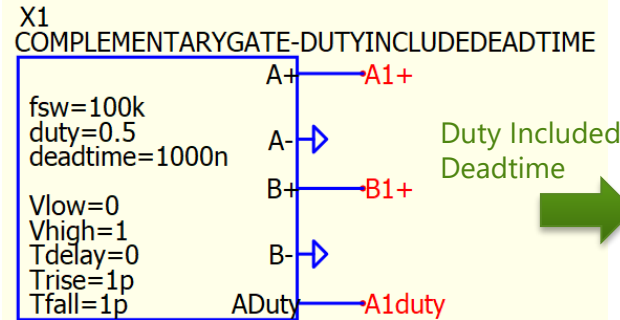
Ideal of PhaseShift_KSK1 subckt



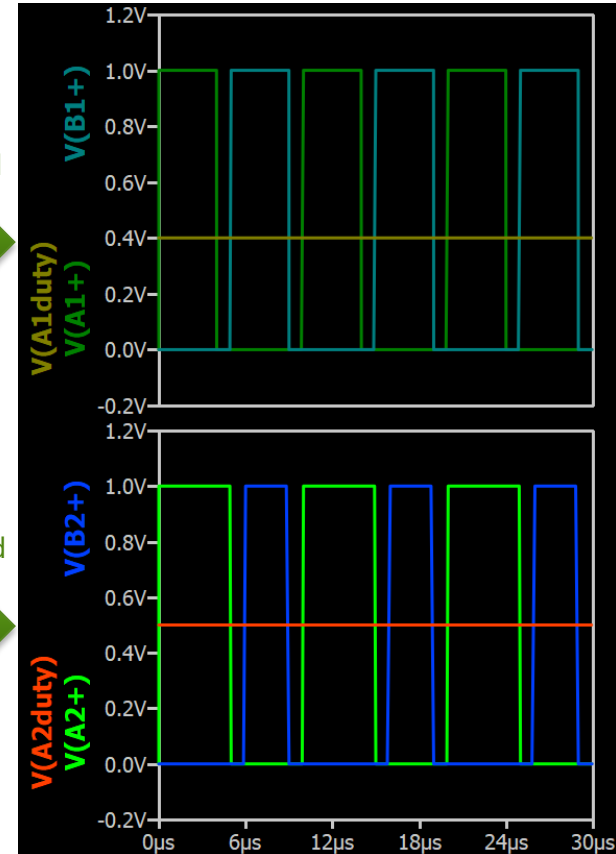
Complementary Gate Signal with Deadtime

Qspice : ComplementaryGate-DutyExcludeDeadtime.qsym | ComplementaryGate-DutyIncludeDeadtime.qsym

- Complementary Gate
 - To generate complementary gate signal (differential output) with deadtime
 - Symbol with duty to include or exclude deadtime
 - Include Deadtime, A+ ON time is $\frac{\text{duty}}{\text{period}} + \text{deadtime}$
 - Exclude Deadtime, A+ ON time is $\frac{\text{duty}}{\text{period}}$



```
.tran 3/100K  
.plot V(A2+) V(B2+) V(A2duty)  
.plot V(A1+) V(B1+) V(A1duty)
```



Complementary Gate Driver with Deadtime

Qspice : Gate-DeadTime.qsym

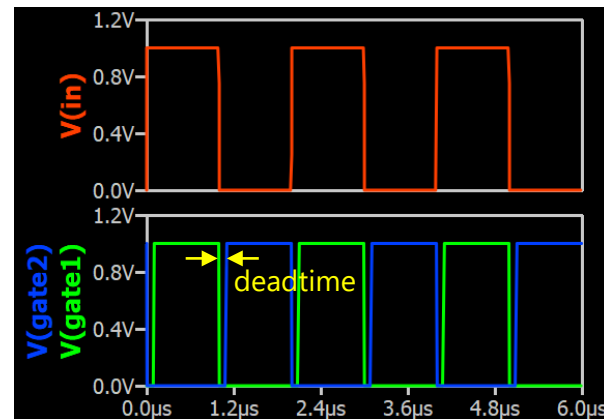
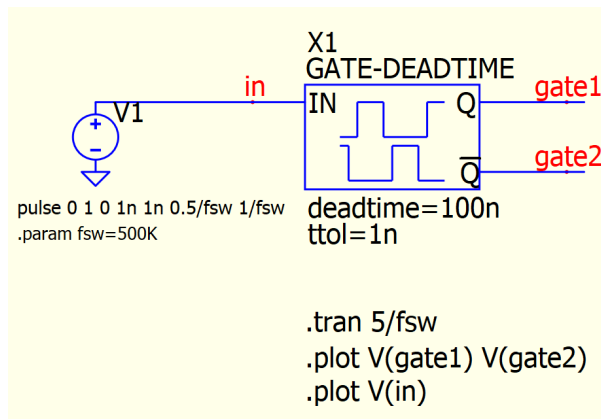
- Complementary Driver

- Symbol

- Gate-DeadTime.qsym
 - Gate driver with complementary output signal separated by deadtime

- Input Parameters

- Deadtime : deadtime in second
 - TTOL : Temporal tolerance
 - (Invisible) Hi : Output High Level
 - (Invisible) Lo : Output Low Level
 - ** beware that as deadtime is required, the ON duration of IN and Q will be different by the deadtime



Voltage Controlled Oscillator (VCO) Behavioral Model

Qspice : VCO-Behavioral.qsym

- Voltage Controlled Oscillator (VCO)
 - This is a behavioral model that generates a pulse-frequency controlled output signal linearly proportional to the input
- Pin Description
 - Ctrl : control voltage to output fmin at minV and fmax at maxV
 - Duty : duty ratio ranging from 0 to 1
 - Out : oscillator output with high/low levels determined by the external voltage relative to Vdd/Vss
 - Frq : frequency value represented in voltage

