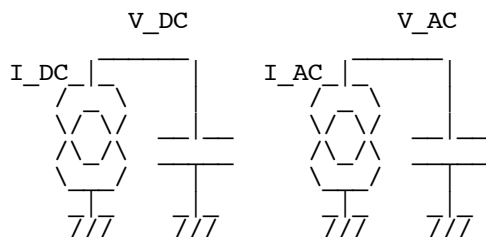


Tranlate_between_PM_FM

* dsauersanjose@aol.com 6/13/08

* www.idea2ic.com

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```
*V_SIN#      NODE_P NODE_N      SIN(  V_DC  AC_MAG FREQ  DELAY  FDamp)
*V_PULSE#    NODE_P NODE_N      PULSE( V_INIT VPULSE TDELAY TRISE  TFALL  PWIDTH PERIOD )
```

```
.OPTIONS  GMIN=1p      METHOD=gear  ABSTOL=1n  TEMP=27  srcsteps = 100  gminsteps = 10
```

```
ITL1=400
```

```
.OPTIONS  RELTOL=.001  ABSTOL=1n  VNTOL=1n  ITL4=500
```

```
*=====
```

IDC	0	VDC	DC	0	PULSE(0 1 1n 1n 1n 10 100)
CDC	VDC	0		1	
RDC	VDC	0		1000K	
IAC	0	VAC	DC	0	SIN(0 1 1 1n)
CAC	VAC	0		1	
RAC	VAC	0		1000K	

```
.control
```

```
tran      1m      1
```

```
run
```

```
set      pensize = 1
```

```
plot     v(vdc)  v(vac)
```

```
plot     v(vac)
```

```
.endc
```

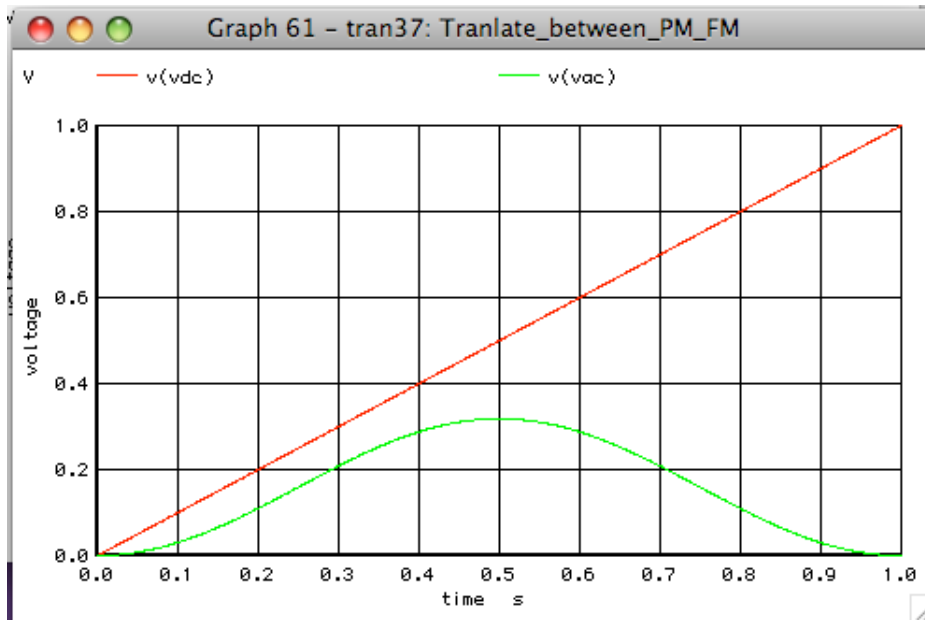
```
.end
```

```
1/2PI = 0.15915494309189535 = 0.3183098861837907
```

```
=====END_OF_SPICE=====
```

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A little thought experiment...

If a DC current of 1 Amp magnitude is applied to a 1 Farad capacitor, then over 1 second it will swing 1 volt.

If an AC current of 1 Amp magnitude is applied to a 1 Farad capacitor, then over 1 second it will swing $\pm 1/2 \cdot \pi$ volts.

If a 1MHz is increased in frequency by a DC magnitude of 1Hz, then over 1 second it will have 1,000,001 cycles as opposed to 1,000,000 cycles. In other words its phase will be off by $2 \cdot \pi$ radians.

If a 1MHz is modulated in frequency by a 1Hz AC signal also at a 1Hz peak magnitude, then over 1 second its Phase will vary $1/2 \cdot \pi$ less than for the DC frequency offset. In other words it will vary ± 1 radian in phase.

The same applies to a 1GHz signal that is modulated by a 1kHz AC signal which is also at a 1kHz peak magnitude. It will vary in phase by ± 1 radian over 1msec.

So FM modulation using the same frequency for both signal modulation and modulation magnitude is equivalent to Phase modulation at with same signal delayed by 90 degrees at 1 radian modulation magnitude.

**Frequency Modulating any Carrier by the same frequency twice
is effectively
Phase Modulating the Carrier at a 1 radian Magnitude**