LM324_REQUIREMENTS

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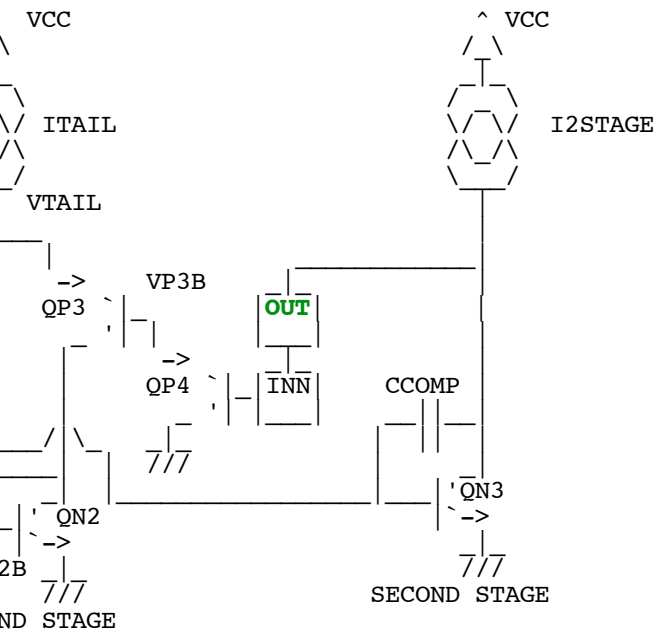
* www.idea2ic.com
*



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```
.OPTIONS  method=gear  GMIN=1e-18

VIN       INP     0       SIN(6   6.7       1K )
QP1       0       INP     VP2B    PNPL    1
QP2       VN3B    VP2B    VTAIL   PNPL    1
QP3       VN2B    VP3B    VTAIL   PNPL    1
QP4       0       OUT     VP3B    PNPL    1

QN1       VN3B    VN2B    0       NPNV    1
QN2       VN2B    VN2B    0       NPNV    1
QN3       OUT     VN3B    0       NPNV    1

VCC       VCC     0       12
ITAIL     VCC     VTAIL   50u
I2STAGE   VCC     OUT     100u

CCOMP     OUT     VN3B    20p

.tran     1u      2m      0       1u

.model      NPNV npn BF=150
.model      PNPL pnp BF=5
```

```
.control
run
set pensize = 2
plot v(inp)  v(out)


.endc
.end

*  ====================END==================================
```

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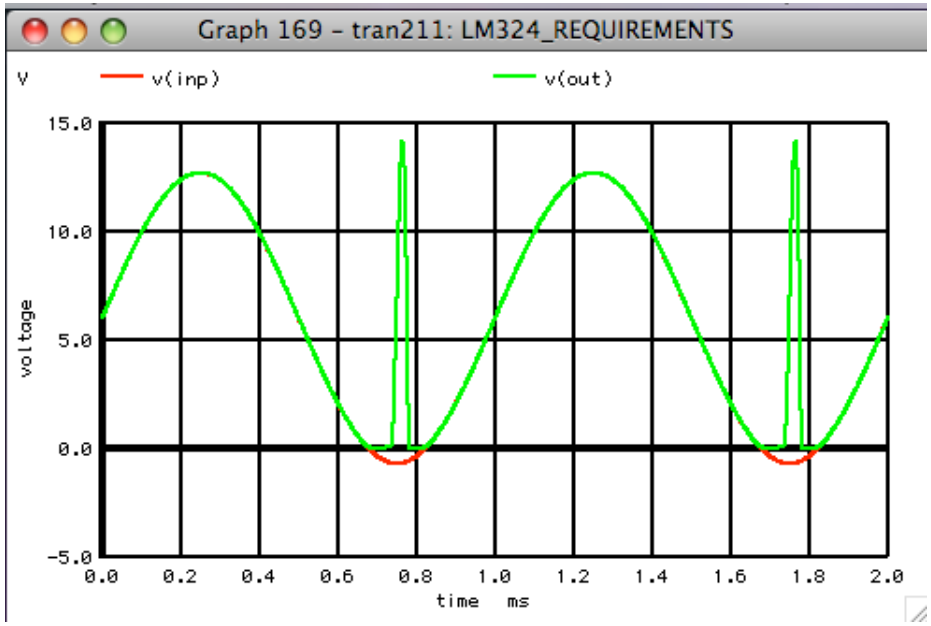
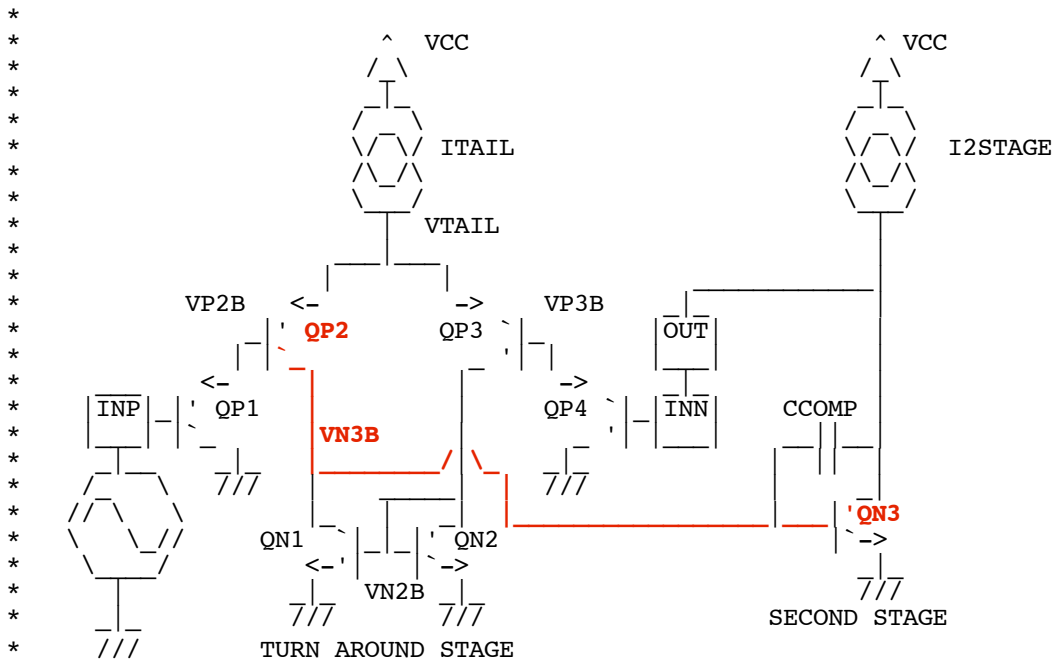
The LM324 is perhaps the best example of a product designed for the automotive market. At the time there was only a single 12volt supply available and hence the development of single supply Op Amps.

Its not that single supply Op Amps can't be used on Dual supplies or visa versa. The single supply title assumes certain input and output features.

For instance the LM324 input can function with both it inputs at the ground level on a single 12V supply. The LM741's inputs cannot do this. The automotive amplifiers were design to operate at a much lower supply voltage. In the case of the LM324, the output can swing to a saturation voltage above ground to give more output voltage swing.



This simulation shows some of the extra features that get designed within an Op Amp that may not appear in the data sheet. If care is not taken at the input stage, swinging a few hundred millivolts below ground can cause the output voltage swing to reverse phase.



The circuit is a simplified LM324 input stage. As long as lowering the base voltage on QP2 increases the base voltage on QN3, then the amplifier is operating normally. If the base of QP2 drops enough to saturate QP2, this is no longer the case.

It had become somewhat of a design standard that the input stage should be able to operate 200mV below the supply voltage over full temperature. The automotive customers seem happy with this level. When RRIO amplifiers came into existence, this spec carried over to being able to swing the inputs 200mV beyond both supplies.