AC_DC_GAINS

```
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* www.idea2ic.com
*                          How to Center the output voltage
*          ____ VCC +12V   And make AC gain externally adjustable
*          |_|  |____|     Using Only five pins.
*     /VCC\
*     \___/      |
*      |         |  R1   40K                  R2 20K
*      |         |_/\  /\  /\_____ VB1  ____/\  /\  /\__
*      |                \/  \/    |_|    |_|   \/  \/   |
*      ///                  QN1`|_|_|'QN2                |
*                            <-'|  |`->                  |
*                           _|     |_|                   |
*                           ///    ///                   |
*                                                        |
*                  +.6V |\                              +6V
*      ____   ____      |+\                              ____
*     |INP|___/VOF\_____|  \_____________/ \____________|OUT|
*     |___|   \___/     |  /                             |___|
*      |_|_              |-/                              |
*     /VIN\            __|/                               |
*     \___/            |                                  |
*      |               |__________________|__|INN| +.6V   |
*      |_|_                                 |___|        |
*      ///                                   _|_         |
*                                            ___ C1      |
*                                     R3  2  |           |
*                                  _/\  /\  /\_|_/\  /\  /\__|
*                                  |   \/  \/      \/  \/
*                                  |_|            VAC    R4  200
*                                 ///
*
.option set srcsteps = 1
VCC     VC      0     DC      12
VIN     IN      0     DC      0    SIN( 0 60m 10k 1n )
VOF     INP     IN    DC      .6
R1      VC      VB1   40k
R2      INN     OUT   20k
X_OPA   INN     INP   OUT    OP_AMP
R3      VAC     0     2
R4      OUT     VAC   200
CAC     INN     VAC   100u
QN1     VB1     VB1   0       NPNP
QN2     INN     VB1   0       NPNP
.tran    10n   .2m    0       10n
.control
run
set     pensize = 2
plot    out vc
.endc
.SUBCKT  OP_AMP INN   INP   OUT
EGBUF    VDIFF  0     INN   INP   1
RGM1     VDIFF  VDIFF2 1k
RGM2     VDIFF2 VGND2  1k
CBW      OUT    VGND2  4p
CSP      VDIFF2 0      4f
EGOUT    OUT    0     VGND2 0    -100000000
.ENDS    OP_AMP
*
*                        CBW _|____|          .SUBCKT OP_AMP INN INP OUT
*                 VDIFF      ____  |____|OUT|
*                      ___/\  ___|_ _|_\      ____  |\
*     |INN|__  _|_    \/   |_ /   \          |INN|__| \
*     |___|_ /   \ RGM VGND |EGOUT|           |___|   \
*           +|EGBUF|        __|    |                  OPA\_|OUT|
*     ____   \___/         |  \___/                    /  |___|
*     |INP|__|  \___/      |__|  GAIN=-1M             |INP|__|  /
*     |___|     |  GAIN=1  ///  |_|                   |___|  /
*                |_|            ///                          |/
*                ///                   ODB = 20MHz
```

```
*
.model    NPNP   NPN( BF=210 IS=1e-17   RC= 100)

.end
```

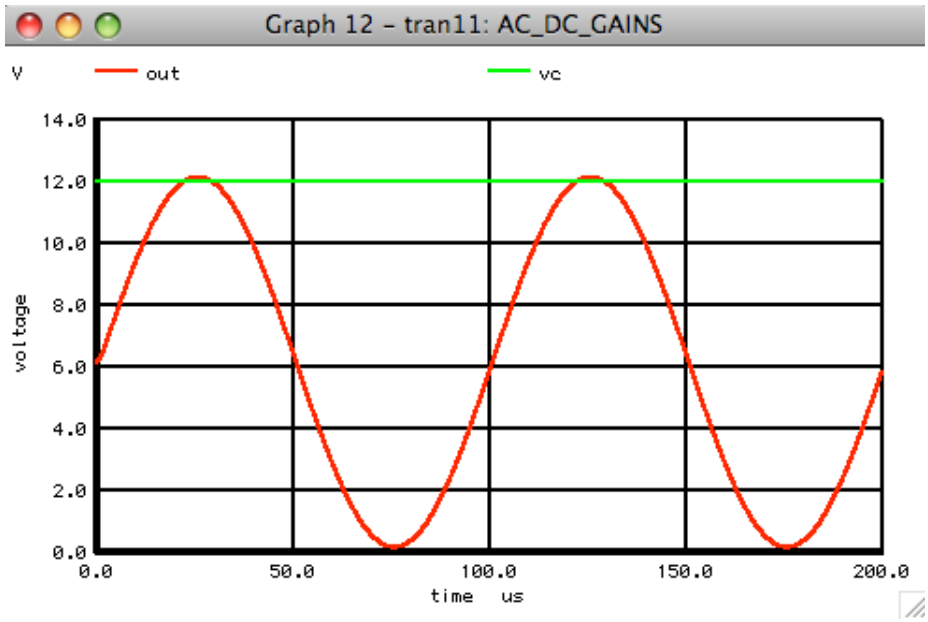
======AC_DC_GAINS==========

```
*
*          ____|VCC| +12V
*          |  |____|
*     /VCC\     |
*     \___/     |   R1   40K                  R2 20K
*       |       |_/\  /\  /\_____ VB1  ____/\  /\  /\__
*       |          \/  \/   |_|     |_|     \/  \/    |
*      ///                QN1`|_|_|'QN2                |
*                          <-'|  |`->                 |
*                          _|     _|_                |
*                         ///    ///                 |
*                                                    |
*                  +.6V |\                           |      +6V
*     |INP|___/VOF\_____|+\                          |
*     |___|   \___/     |  \_____________/ \_________|__|OUT|
*       |               |  /                          |   |___|
*     /VIN\             |-/                           |     |
*     \___/          ___|/                            |     |
*       |            |_____________________|__|INN| +.6V|     |
*      ///                                   |___|     |     |
*                                            _|_      |     |
*                                             |  C1   |     |
*                                   R3  2    |       |     |
*                              _/\  /\  /\_|_/\  /\  /\__|
*                             |   \/  \/       \/  \/
*                             |                VAC    R4  200
*                            ///
```

This circuit satisfied the automotive audio power amplifier requirement of putting out a maximum amount of power on a relatively low supply current while also allowing the audio AC gain to be externally set from 50 to 300.

A further challenge was that this was all to be done in the new TO-220 five lead power package. SGS should be credited with coming up with the clever way to used the INN pin to both center the output voltage between the supply voltage and ground while also allowing the INN pin to set the AC Gain.

The trick is that this is a power amplifier. So it resistors R3 and R4 could be make much smaller than usual. This low impedance network would be able to dominate in the AC mode over the much high DC feedback network consisting of R1, QN1, QN2, and R2.



***#1==========WinSpiceVersion==========**

```
AC_DC_GAINS
*
*            ____|VCC| +12V
*          _|_
*        /VCC\
*        \___/          R1   40K                  R2 20K
*          |             _/\   /\   /\_____ VB1 ____/\   /\   /\__
*          |              \/   \/   \/     |    |     \/   \/     |
*         ///                          QN1`|_|_|'QN2              |
*                                       <-'|   |`->               |
*                                          |    |                 |
*                                         ///  ///                |
*                                                                 |
*                          +.6V |\                              +6V
*        |INP|___/VOF\_____|  +\                                 |
*        |___|   \___/     |    \_____________/ \_____________|__|OUT|
*          |                |    /                                |___|
*        /VIN\            __|  -/                                 |
*        \___/             |  /                                   |
*          |               |_____________________|__|INN| +.6V     |
*          |                                       |___|          |
*         ///                                      _|_           |
*                                                   ___ C1        |
*                                        R3   2                   |
*                                     _/\   /\   /\_|_/\   /\   /\__|
*                                    |   \/   \/       \/   \/
*                                   _|_                VAC    R4   200
*                                  ///
*
.option set srcsteps = 1

VCC     VC      0     DC      12
VIN     IN      0     DC      0     SIN( 0 60m 10k 1n )
VOF     INP     IN    DC      .6
R1      VC      VB1   40k
R2      INN     OUT   20k
X_OPA   INN     INP   OUT     OP_AMP
R3      VAC     0     2
R4      OUT     VAC   200
CAC     INN     VAC   100u
QN1     VB1     VB1   0       NPNP
QN2     INN     VB1   0       NPNP
```

```
.tran    10n   .2m    0       10n

.control
run
set     pensize = 2
plot    out vc

.endc


.SUBCKT  OP_AMP INN   INP  OUT
EGBUF    VDIFF  0     INN  INP  1
RGM1     VDIFF  VDIFF2 1k
RGM2     VDIFF2 VGND2  1k
CBW      OUT    VGND2  4p
CSP      VDIFF2 0      4f
EGOUT    OUT    0     VGND2 0    -100000000
.ENDS    OP_AMP

*
*                       CBW _|_____|            .SUBCKT OP_AMP INN INP OUT
*                 VDIFF       ____|_____|OUT|
*      ____          ___/\   ____|  _|_          ____   |\
*     |INN|__      _|_     \/   |_ /   \         |INN|__| \
*     |___|_ /   \ RGM VGND |EGOUT|                |___|   \
*          +|EGBUF|        __|     |                      OPA\_|OUT|
*      ___ __|       |       |  \___/                      /|____|
*     |INP|__|  \___/        _|_   |  GAIN=-1M    |INP|__|  /
*     |___|       |  GAIN=1  ///  _|_              |___|  /
*                _|_                ///                    |/
*                ///                     ODB = 20MHz
*
.model    NPNP   NPN( BF=210 IS=1e-17   RC= 100)


.end
```