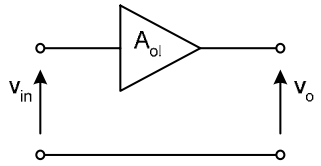
Part 20: Effect of feedback on distortion

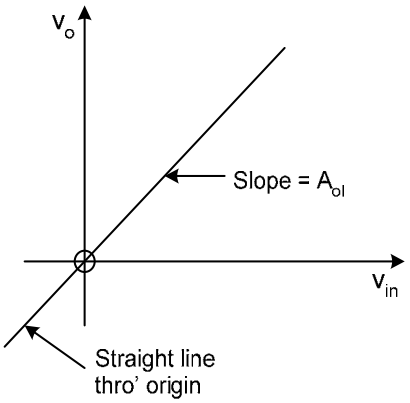
Negative feedback can reduce the amount of distortion produced by an amplifier.

1) What is **distortion**? When output is not a magnified, but otherwise exact copy of input.
2) Why does negative feedback affect distortion?

DIFFICULT to explain! – we look at examples. First, look at the Voltage Transfer Curve (VTC) of an amp.

For LINEAR amp, VTC is





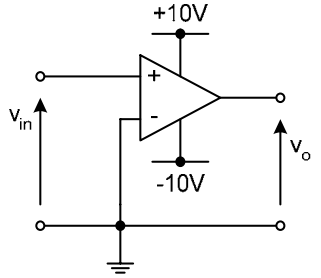
VTC ≡ graph of v_o vs v_{in}

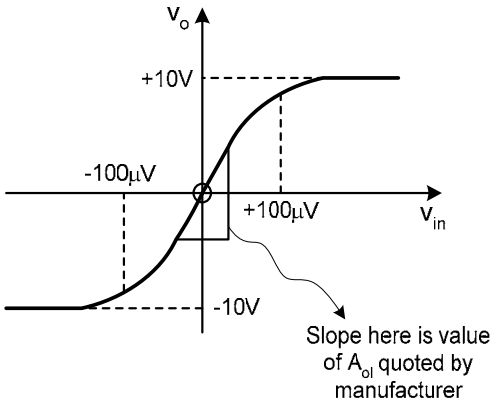
Real amps only approx linear because:

1. Transistors are not very linear devices

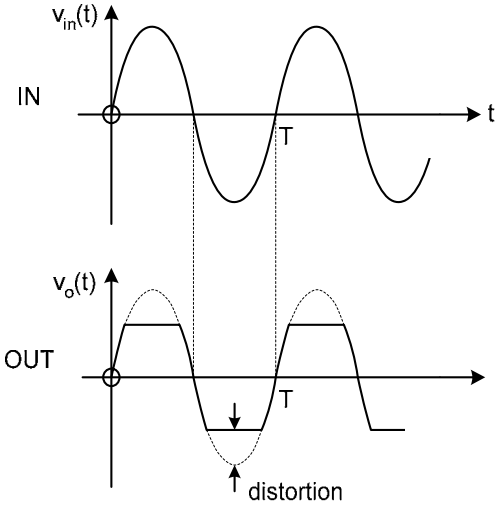
2. Output voltage swing is limited by supply rails

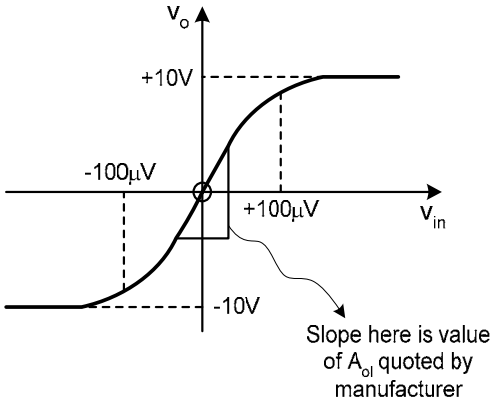
VTC of a **real** op-amp looks like





For this op-amp, if v_{in} is a sinewave, output will be distorted – having flattened peaks



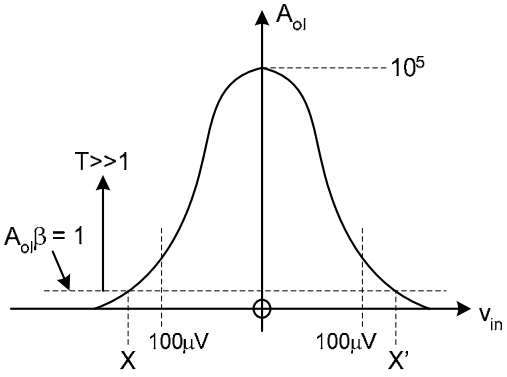


We should now define gain A_{ol} as

$A_{ol} = \frac{dv_o}{dv_{in}}$ - ie as slope of v_o *vs* v_{in} curve

- $\therefore A_{ol}$ <u>varies</u> with value of v_{in}

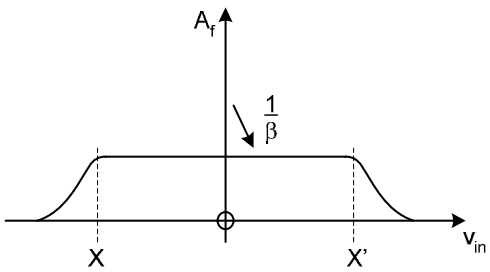
For a real op-amp, A_{ol} then varies as



If we use this op-amp with <u>feedback</u> then since

$A_f \cong \frac{1}{\beta}$ provided T>> 1 (ie $A_{ol}\ \beta 1$)

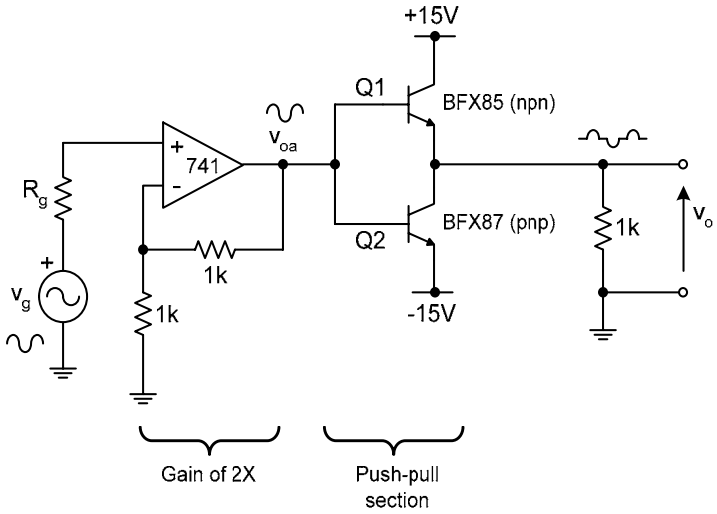
Then A_f is **determined** by β in spite of variation of A_{ol} away from origin – we can plot A_f vs v_{in}



So provided, output is not too close to supply rails, distortion is much less (by a factor of 1 + T!) – gain A_f is **independent** of v_{in} until v_{in} close to X or X'.

Another example

The transistors constitute a class B 'push-pull' power amplifier.



During the positive half cycle: Q_2 is OFF; Q_1 is ON

Provided $v_{oa} > 0.7V$

then output **follows** input ie $v_o = v_{oa} - 0.7$

During $-ve$ half cycle, Q_1 is OFF;

Q_2 is ON provided $v_{oa} < 0.7V$

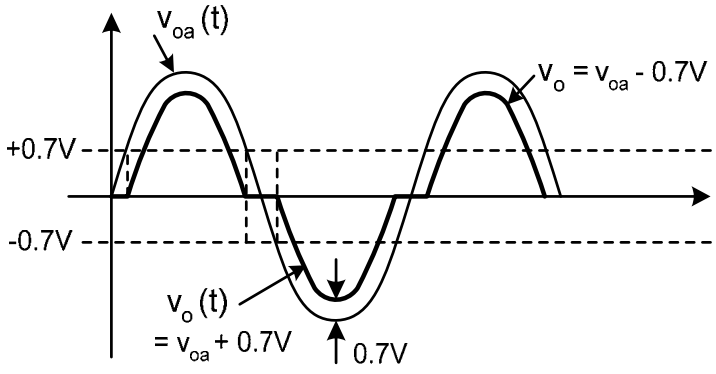
output follows input ie. $v_o = v_{oa} + 0.7V$

When $-0.7V < v_{oa} < +0.7V$
THERE IS NO OUTPUT

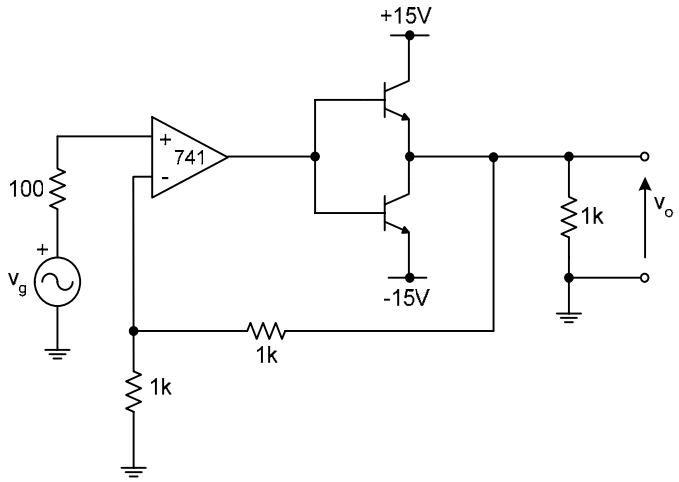
– both transistors are OFF

– we get **"Cross-over Distortion" .**

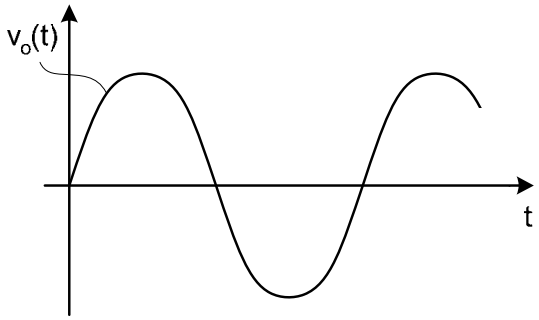
So we expect (see opposite)



BUT if we reconnect amplifier, so that push-pull circuit is **within** feedback loop:

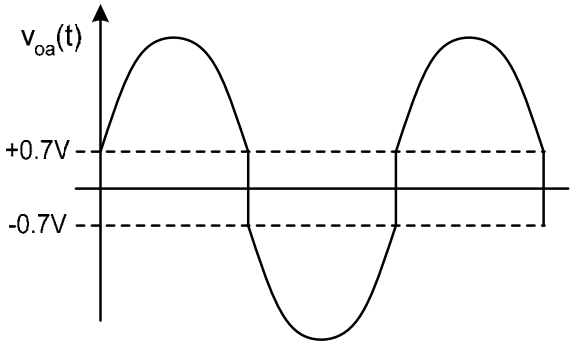


Something almost magical happens!



- output practically undistorted!

For this reason, look at op-amp output



-output jumps between $-0.7V$ & $+0.7V$ levels to force the push-pull amplifier through its "dead band" quickly. Input to push-pull is pre-distorted in order to compensate for the distortion produced by the push-pull. Not really magic – but a pretty smart idea…beat nature at its own game..