pedance source we can also consider the bipolar transistor a transconductance device, the collector current being determined by the base-emitter voltage.

The transconductance g_m of a JFET is given by:

$$g_m = -\frac{2\,I_{dss}}{V_P}\left[1 - \frac{V_{gs}}{V_P}\right] \quad (3)$$

where V_p is the pinch-off voltage. We get the highest g_m when V_{gs} = 0V, i.e. when the JFET is working at Idss:

$$g_m = -\frac{2\,I_{dss}}{V_P} \quad (4)$$

A typical high g_m device like the 2SK170 with Idss = 6.5mA and a V_p = -0.4V, will have a g_m of 32 mS. If we use a 2SK170 with Idss = 10mA then we get 40mS. The gain of the JFET in grounded source connection is equal to -g_m*R, where R is the drain resistor. For the above JFET with R = 1k, it will be -32 with Idss = 6.5mA and -40 with Idss = 10mA.

The g_m of the bipolar transistor is:

$$g_m = \frac{I_c}{V_T} \quad (5)$$

where V_T = kT/q, which is approximately 25mV at room temperature. So the g_m will be

$$g_m = \frac{I_c\,(mA)}{25mV} \quad (6)$$

A bipolar transistor working at 1mA collector current has a g_m of 1mA/25mV = 40mS. At 10mA its 400mS! The gain is again -g_m*R, so with 10mA collector current and a 1k collector resistor we get -400, i.e. significantly higher than the JFET.

Looking at the grounded gate/grounded base configurations in Figure 2b, the major difference compared to 2a is the input impedance. Looking into the source of the JFET we see an impedance of 1/g_m, which in the case of the 2SK170 with Idss = 6.5mA is equal: 1/32mS = 31 Ohm and with Idss = 10mA it is 25 Ohm. Not exactly "dead short", but we are going to do something about that later. The input impedance of the bipolar transistor is also 1/g_m, which is equal to the intrinsic emitter resistance: re = V_T / Ic = 25mV/Ic mA. So a BJT has an input impedance in grounded base configuration of 25 Ohm at 1mA. Also not "dead short", but it is easy to reduce this by operating the BJT at higher currents; 10mA would give you 2.5 Ohm! The gain of the grounded gate/grounded base configuration is the same as the gain for grounded source/grounded emitter, g_m*R, but this time the output and the input are in phase.
As we have seen, the grounded gate and grounded base configuration are working with current in-current out. In order to reduce their input impedance to "dead short", we can do several things. The