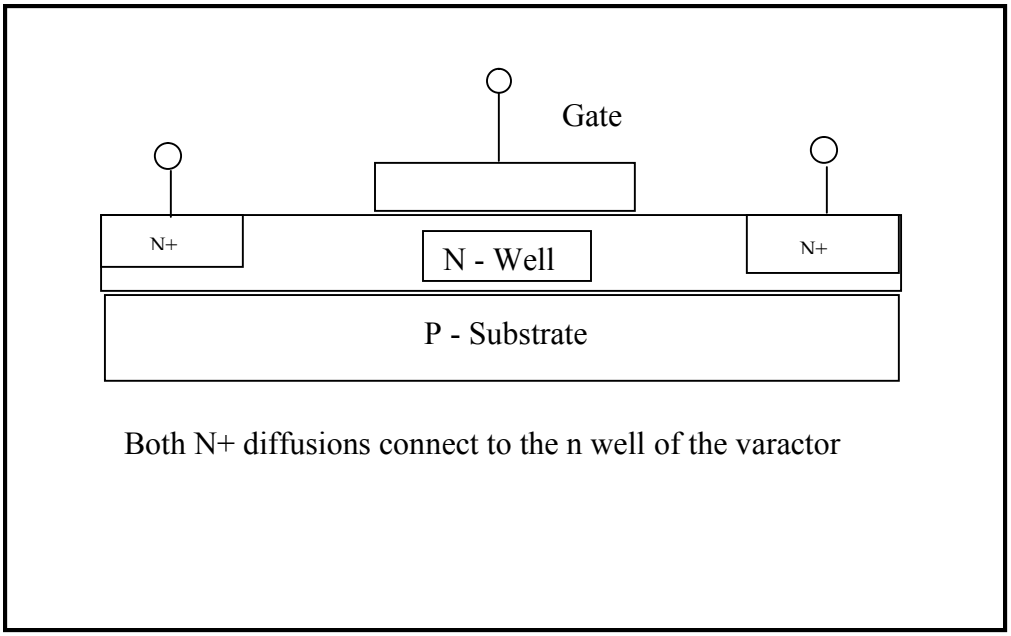
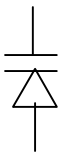
The MOS Varactor

1.0 MOS Varactor

The MOS varactor is formed by thin gate-oxide over Nwell, with N+ implants at both ends of the NWELL to form ohmic contacts with the varactor Nwell region. The cross section of this device is shown in Figure 1.0





Symbol

Figure 1.0

The equivalent circuit of the device is shown in FIGURE 2.0 generated for use in high frequency circuits.

Signal Processing Group Inc., technical memorandum, June 2010. website: http://www.signalpro.biz.

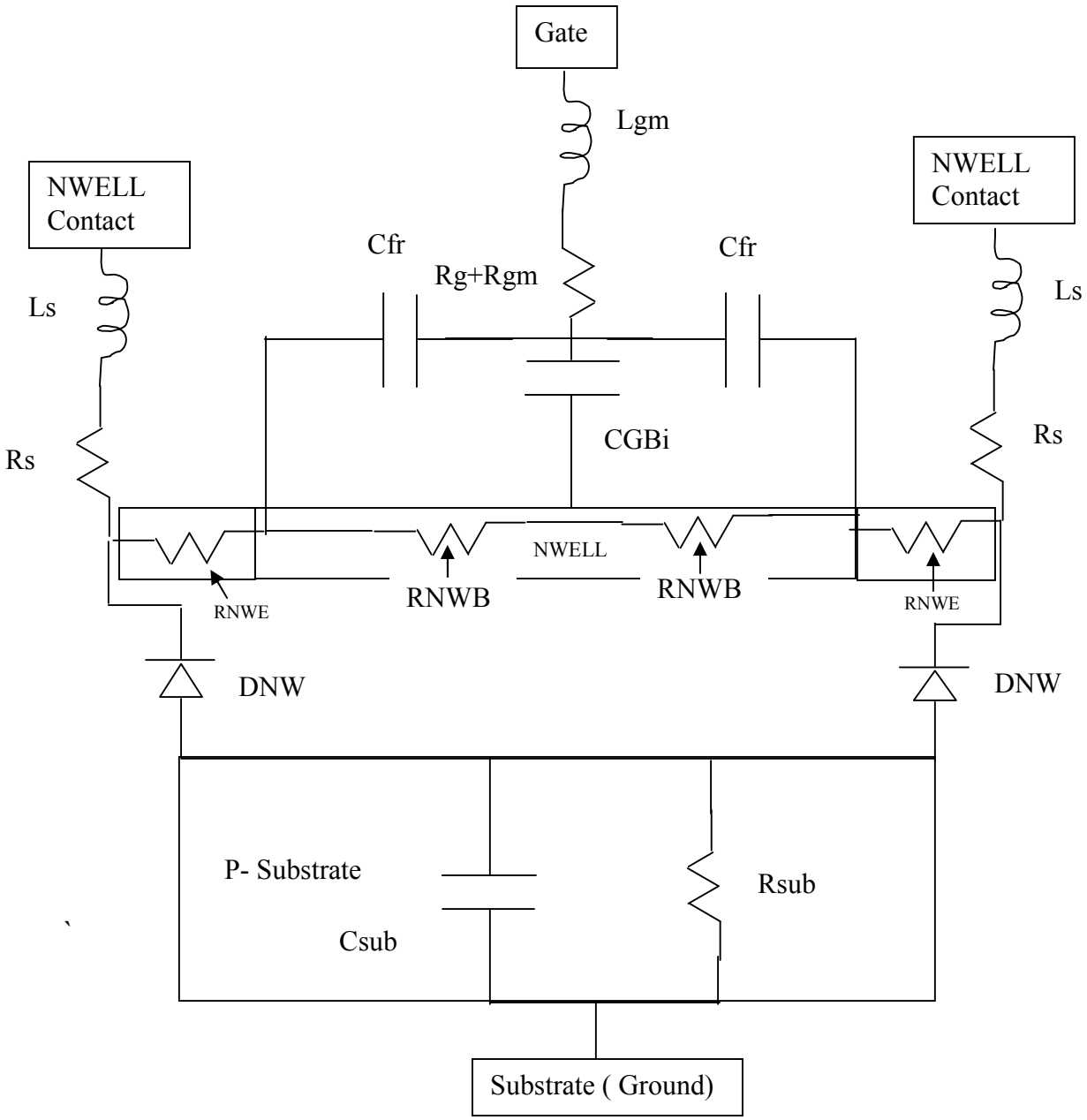


Figure 2.0

In the equivalent circuit:

C_{Gbi}	=	Intrinsic MOS capacitor
C_{fr}	=	Overlap and fringing capacitance for poly and metal 1
RNWB	=	Nwell resistance under oxide
RNWE	=	Nwell end and contact resistance
Rg	=	Gate poly resistance
Rgm	=	Parasitic resistance of gate metal
Lgm	=	Parasitic inductance of gate metal

Signal Processing Group Inc., technical memorandum, June 2010. website: http://www.signalpro.biz.

Ls	=	Parasitic inductance of NWELL metal
Rs	=	Parasitic resistance of NWELL metal
DNW	=	NWELL to Substrate diode
RSUB	=	Substrate resistance
CSUB	=	Substrate capacitance

A typical MOS varactor characteristic is described by: (Depending on the technology and construction, available from the technology vendor)

Q = Varies from >100 at 1 Ghz to 10.0 at 10 Ghz
C(VgB) = 0.25pF (Vgb=0) to 0.3pF (Vgb>0.5)
* Vgb = gate to nwell voltage.

Note that the above parameters are for one section of a small MOS varactor. If the need is to get larger values, sections (or slices) can be paralleled and connected in series to provide higher performance.

Figure 3.0 below shows a PSPICE simulation of a low pass filter using a MOS varactor. The multiple characteristics are for different Vgb.

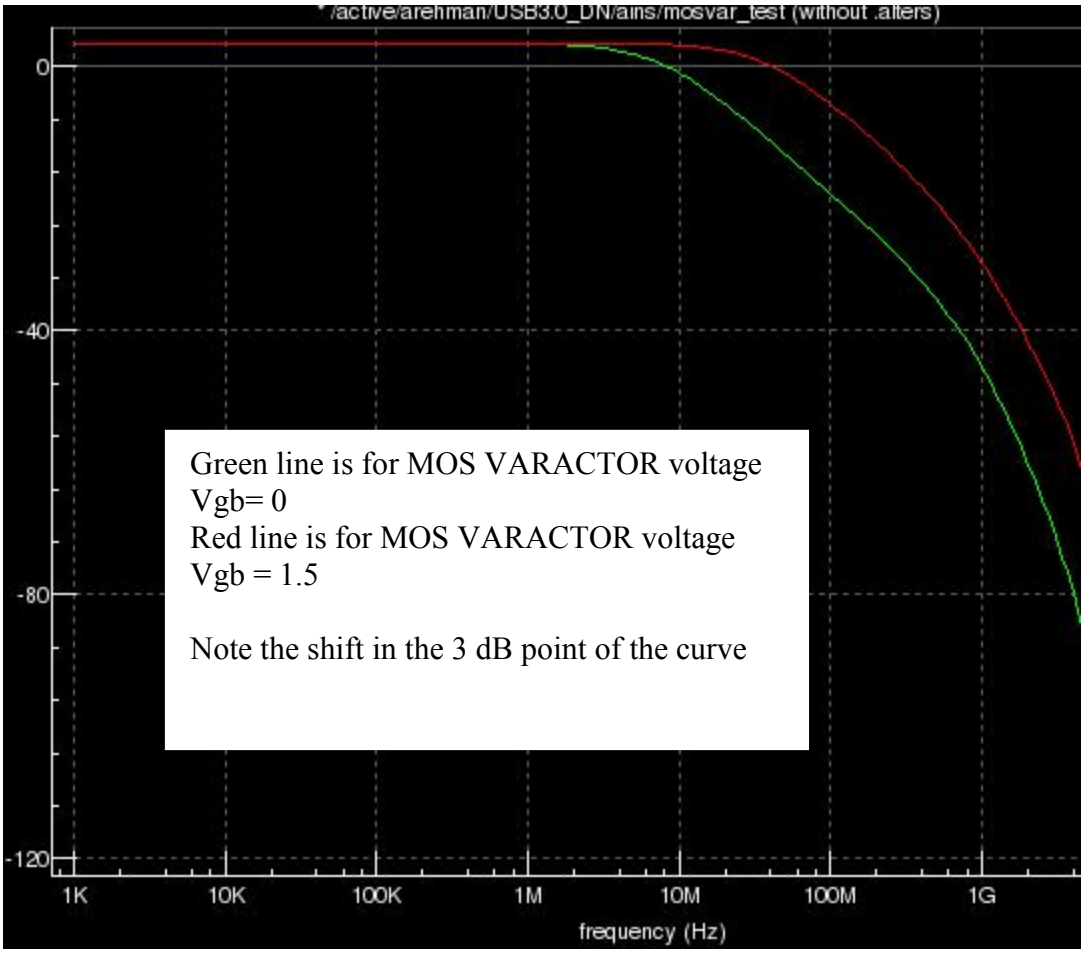


Figure 3.0

The connections to the varactor are to the gate and Nwell (via the N+ contacts). The variation of the voltage across these connections generates the varying capacitance. The gate width W, and length L, control the capacitance tuning range and quality factor, Q. Increased W and L provide higher tuning range as the contribution of fixed capacitance is reduced. However, the quality factor is reduced due to increased Nwell and poly gate resistance.

The varying capacitance is used for a multiplicity of applications, some of which are noted below:

Some applications of the varactor:

1) Change the frequency of the VCO in a PLL
2) Tune the frequency characteristics of high frequency filters

Signal Processing Group Inc., technical memorandum, June 2010. website: http://www.signalpro.biz.

3) Adaptive equalizers (the varactor uses the feedback signal)
4) Tune radio receivers and transmitters
5) Adjust time constants of fast switching circuits

Signal Processing Group Inc., technical memorandum, June 2010. website: http://www.signalpro.biz.