Experiment 1: C-V Measurements

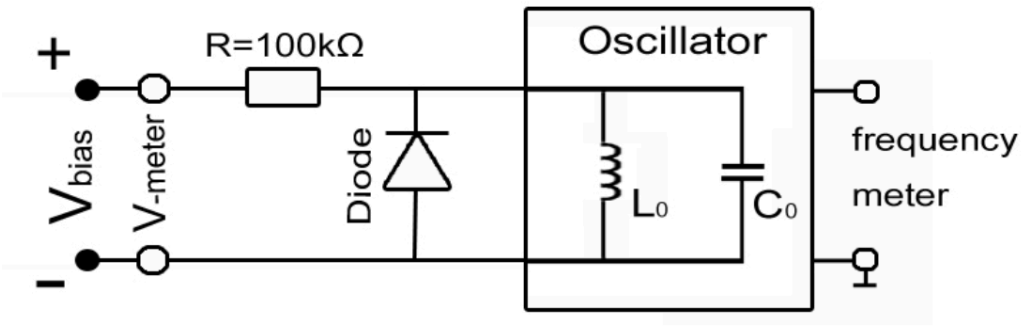

Figure 1: Circuit Diagram for CV Measurements

The circuits shown in Figure 1 is used to conduct the CV Measurements.
The open-loop frequency of the oscillator $f_0 = 1629.9 \pm 0.05$kHz.
The "10 pF" capacitor $C_{10} = 10.48 \pm 0.005pF$.
With C_{10} connected, the frequency $f_{10} = 1467.4 \pm 0.05$kHz.
From theories of oscillators, the circuit capacitance $C_0 = \frac{C_{10}}{\left(\frac{f_0^2}{f_{10}^2}\right)-1} = 44.84 \pm 0.054$pF. The error ΔC_0 is found by: $\Delta C_0 \approx |\frac{\partial C_0}{\partial C_{10}}|\Delta C_{10} + |\frac{\partial C_0}{\partial C_0}|\Delta f_0 + |\frac{\partial C_0}{\partial f_{10}}|\Delta f_{10}$.
In this experiment, the total capacitance C_r is consisted of the stray capacitance C_s, and capacitance of the depletion region C_{diode}: $C_r = C_s + C_{diode}$.
Where C_s is constant and $C_{diode} = A_c(\frac{\epsilon_s e N_d}{2(V_o - V_{rev})})^{1/2}$, $V_o = 0.5V$ is the built-in voltage.
The bias voltage V_{rev} is varied in a range and corresponding C_r is found from $C_r = C_0[(\frac{f_0}{f_r})^2 - 1]$, where f_r is the frequency measured on the frequency meter.
The data table is shown in Figure 4 in appendix.
To extrapolate C_s and N_D from the data, a scatter plot and a linear fit are applied, where C_r is plotted against $(V_0 - V_{ref})^{-1/2}$.
Rearrangements gives: $C_r = C_s + [A_d(\frac{\epsilon_s e N_D}{2})^{1/2}] \cdot (V_0 - V_{ref})^{-1/2}$.
For the linear fit $y = kx + b$, $C_s = b$ and $N_D = \frac{2}{\epsilon_s e}(\frac{k}{A_c})^2$.

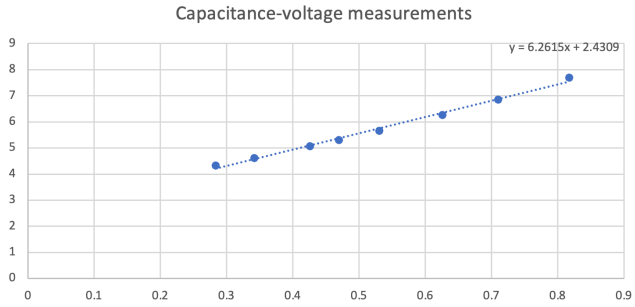

Figure 2: Linear Fit of the CV Measurements

With k = 6.2615, b = 2.4309, $C_s = 2.4309pF$, $N_D = 8.2 \times 10^{26} m^{-3}$.

Experiment 2: I-V Measurements

Reverse Bias

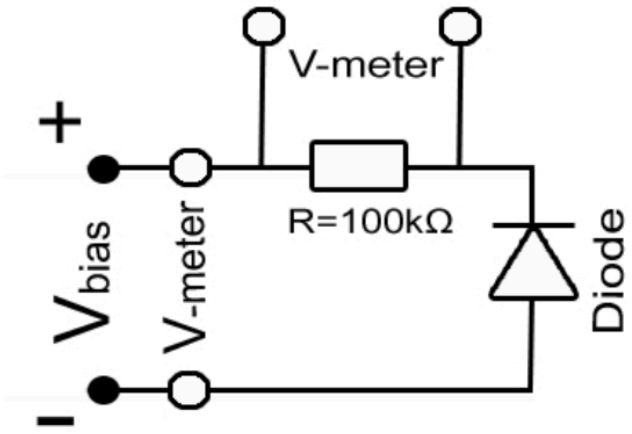

Figure 3: Circuit Diagram of Measuring Reverse Saturation Current

Figure 3 shows the circuits diagram for measuring reverse saturation current under reverse bias.

Weak Forward Bias

Strong Forward Bias

Data Tables

	10 pf as measured on bridge ↓	Take V_o= 0.5 V	Measured Frequency [kHz]	C_r is C_{SBD} corresponding to f_r
(+ 10pf) $V_{rev\ \ none}$	C_{10} = 10.48 [pF]		f_{10}= *1467.4*	$C_{10}/[(f_0^2/f_{10}^2)-1]$ = ↓
(+ 0 pf) $V_{rev\ \ none}$			f_0= *1629.9*	C_o = 44.83546
Suggested **V_{rev} [V]**	**Measured** **V_{rev} [V]** ↓	**$(V_o - V_{rev})^{-½}$** **[$V^{-½}$]** ↓	f_r = ↓	**$C_o[(f_0^2/f_r^2)-1]$** **= C_r** ↓
–12.0	11.95	0.283410101	1556.63	4.320112786
–8.0	8.05	0.341992784	1551.9	4.620209707
–5.0	5.01	0.426014323	1544.992	5.063452871
–4.0	4.035	0.469581906	1541.339	5.300255742
–3.0	3.048	0.530894461	1535.823	5.661033323
–2.0	2.053	0.625856249	1526.768	6.261781717
–1.5	1.484	0.709952293	1517.936	6.858122776
–1.0	0.998	0.817041457	1505.866	7.690125286

Figure 4: Data Table for CV Measurements

Suggested $V_{Reverse}$ [V]	Measured $V_{Reverse}$ *[V]*	Measured SBD (voltage drop at the resistor when SBD connected) $V_{Reverse}$ [mV]	Measured *SBD* I_{Rev} [µA]	Measured $V_{Reverse}$ *[V]*	Measured p-n ((voltage drop at the resistor when p-n diode connected) $V_{Reverse}$ [mV]	Measured *p-n diode* I_{Rev} [µA]
–0.25	0.2504	15.2	0.152	0.2497	0.2	0.002
–0.50	0.5009	16.2	0.162	0.4962	0.3	0.003
–1.0	1.002	17.6	0.176	0.994	0.4	0.004
–2.0	2.004	19.9	0.199	1.999	0.4	0.004
–4.0	4.004	23.8	0.238	4.042	0.5	0.005
–6.0	6.032	26.9	0.269	6.021	0.6	0.006
–8.0	8.01	29.7	0.297	7.99	0.6	0.006
–10.0	9.99	32.5	0.325	10.09	0.6	0.006
–12.0	12.06	35.4	0.354	11.93	0.6	0.006

Figure 5: Data Table for Reverse Saturation Current