



# **MBP CV Measurement Guidance**

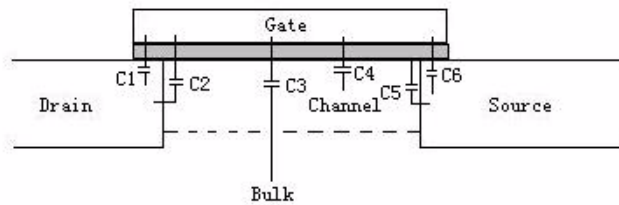
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This chapter is to give user a guidance of how to establish a basic test environment using Agilent 4284A. DC bias will be done by Agilent 4155. For each target's characterization, the Guidance will be divided into two sections, the setup of the measurement instrument and the initial configuration on MBP.

## 1 Capacitors in MOSFET

Following picture shows the capacitor distribution in a MOSFET:



**FIGURE 1** Figure 1 Cross Section for MOSFET

It can be seen that C1 and C2 are the overlap capacitors between gate and drain/source. C2 and C5 are the sidewall capacitors between gate and drain/source. C3 is the gate-bulk capacitor while C4 is the Gate-Channel capacitor.

## 2 Conventions in CV Measurement

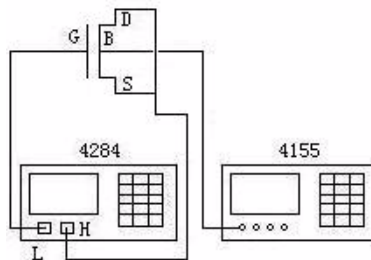
- The device is assumed to be symmetric, between drain and source, if not specified.
- $C_{gc}$  means the capacitor between Gate and Channel. As described later, this also includes the overlap capacitor between Gate and Drain/Source.
- $C_{gb}$ , the capacitor between gate and bulk
- $C_{gd}$ ,  $C_{gs}$ , capacitor between Gate and Drain/Source.
- $C_{gg}$ , Gate capacitor summation
- There are four ports on 4284: Hcur, Hpot, Lcur, Lpot. This chapter assumes Hcur and Hpot shorten as one port, H end while Lcur and Lpot shorten as one, L end.
- A CV characterization needs to establish some DC bias. Though Agilent provides 42841A and 42842B etc. to cover such demands.

However, in most cases, user only needs a 4145/4155 IV meter, instead.

- "Zero" calibration should be done before every types of measurement. User needs to lift the probe tips slightly click the Zero button on the measurement interface. The result may be incorrect if the probe pad is lifted too much. User may need to characterize a series of curves for one device. Please do remember to do a "Zero" calibration before each curves. Only "zero" once at first for each device is NOT RIGHT!
- There will be large dc current when doing Cgd/Cgs characterizations, so please NEVER connect L end to the Drain/Source Pad! Also, 4284 is better than 4275 in this case.

### 3 Cgc\_Vgs\_Vbs Characterization

In order to measure the Capacitance between Gate and Channel, the instrument should be connected as following picture.



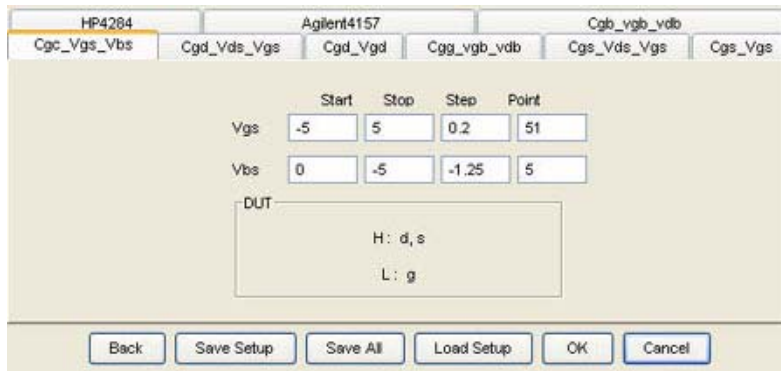
**FIGURE 2** Figure 2 Cgc Instrument Setup

The Low end is connected to the gate so that the noise from bulk can be eliminated. Thus, the result resolution can be more precise.

The body bias is provided by the IV meter 4155 in this example.

This methodology includes the overlap capacitance of drain and source into the final result. So the  $C_{gc} = C_4 + C_1 + C_6$ , as shown in Figure 1

The MBP configuration looks like:

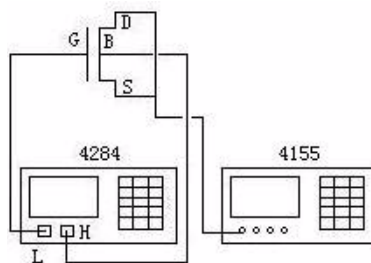


**FIGURE 3** Figure 3 MBP Configurations for Cgc

It can be seen that the H and L end connection is hard coded into MBP and user only needs to modify the bias sweep of Vgs and Vbs. Notice Vgs is swept by 4284 while Vbs is provided by 4155.

#### 4 Cgb\_Vgb\_Vdb Characterization

The instrument organization is:



**FIGURE 4** Figure 4 Cgb Instrument Setup

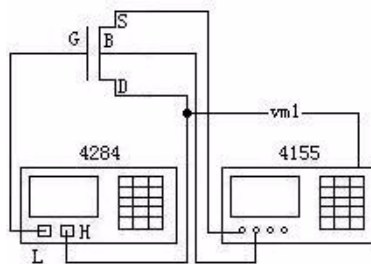
The drain/source bias is provided by the 4155 through a connector. Others are similar with the Cgc's procedure.

The configure dialog for Cgb\_Vgb\_Vd looks like



**FIGURE 5** Figure 5 MBP Configurations for Cgb

## 5 Cgd\_Vds\_Vgs Characterization



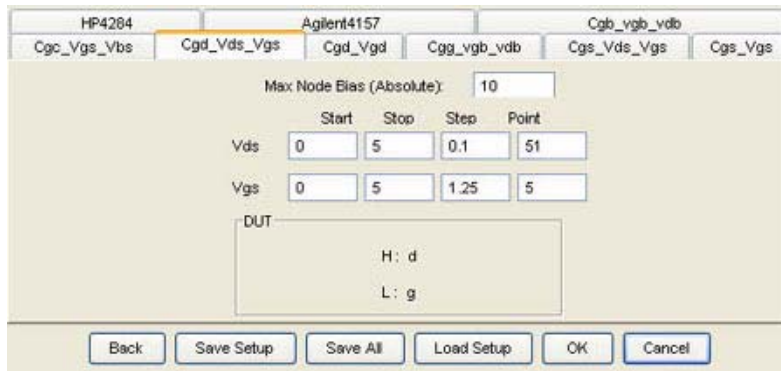
**FIGURE 6** Figure 6 Cgd\_Vds\_Vgs

Alike above ones, 4155 provides the DC bias; the low end is connected to the gate to avoid noise.

However, a DC current will flow through from drain to source, thus into 4284. This current, together with the intrinsic 100 ohms resistance of 4284 contribute a  $\approx 5V$  to the drain.

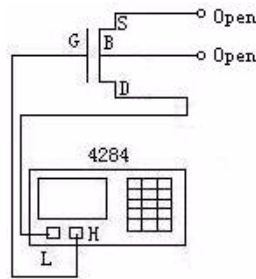
To eliminate it, simply add a voltage meter at the Drain pad to read the DC voltage. User may need to use the vm1/vm2 channel in 4145/4155.

The MBP configuration dialog looks like:



**FIGURE 7** Figure 7 MBP Configuration

## 6 Cgd\_Vgd Characterization



**FIGURE 8** Figure 8 Cgd\_Vgd

This is a very simple analysis for the capacitance between the gate and drain regardless of the operation point of MOSFET. Notice the bulk and source are open and the H&L ends are exchangeable this time.

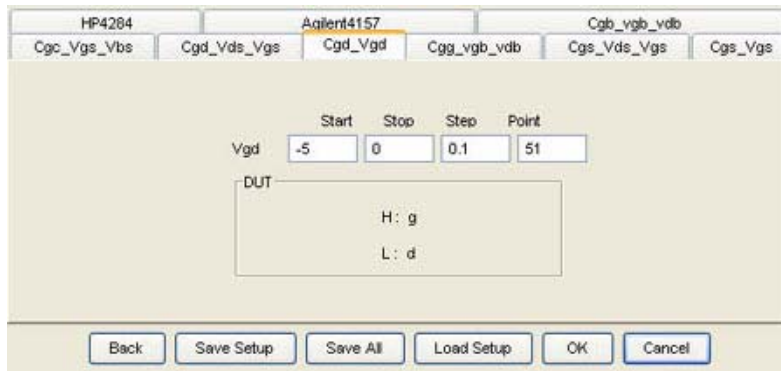


FIGURE 9 Figure 9 MBP Configuration Dialog

**TIPS**

The Source capacitors are same with the Drain side. Just pay attention to the voltage monitor connection.

**7 Cgg Characterization**

The instrument setup is shown like

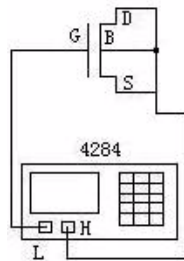


FIGURE 10 Figure 10 Cgg Instrument

This analysis measures the total capacitor of the gate. No IV meters are needed for the DC bias. So the final result will be only one curve regardless of any other bias conditions.

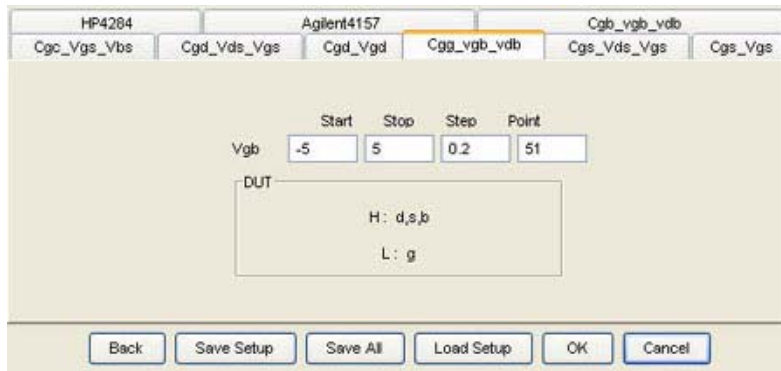


FIGURE 11 Figure 11 MBP Configuration Dialog