Welcome!

Device Characterization with the Keithley Model 4200-SCS Characterization System

Guarding

Guarding can reduce the effects of stray capacitance from affecting measurement accuracy.

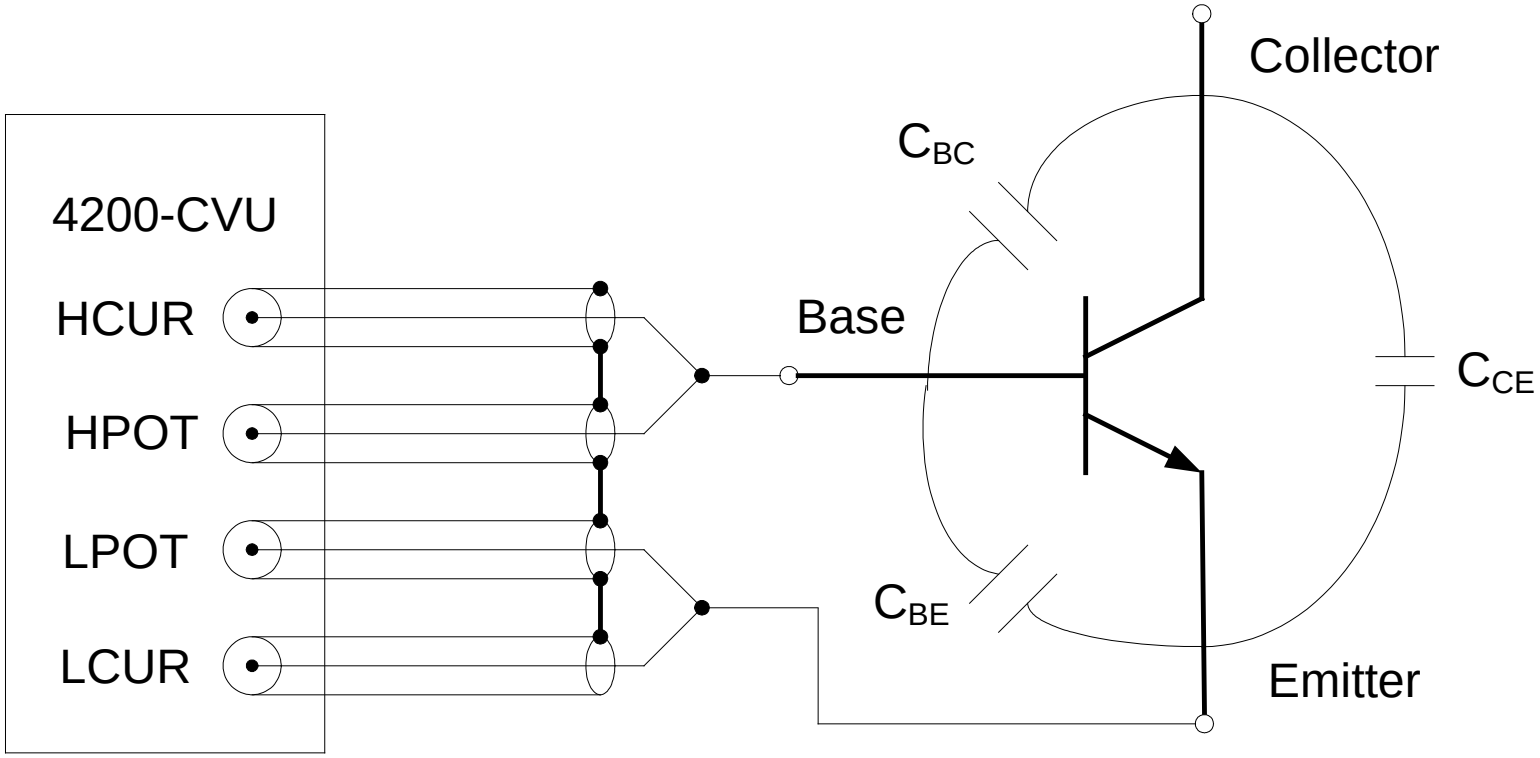
The Guard terminal is the outside shield of the coax cables of the 4200-CVU.

Examples of Guarding:

1. When only one parameter (between two terminals) of a multi-terminal device (three or more terminals) is being measured. The unused terminals should be guarded.

2. Guard the chuck for capacitance measurements between terminals on a wafer.

Measuring One Parameter (C_{BE}) of BJT



$$C_{MEAS} = C_{BE} + \left(\frac{C_{BC} \bullet C_{CE}}{C_{BC} + C_{CE}} \right)$$

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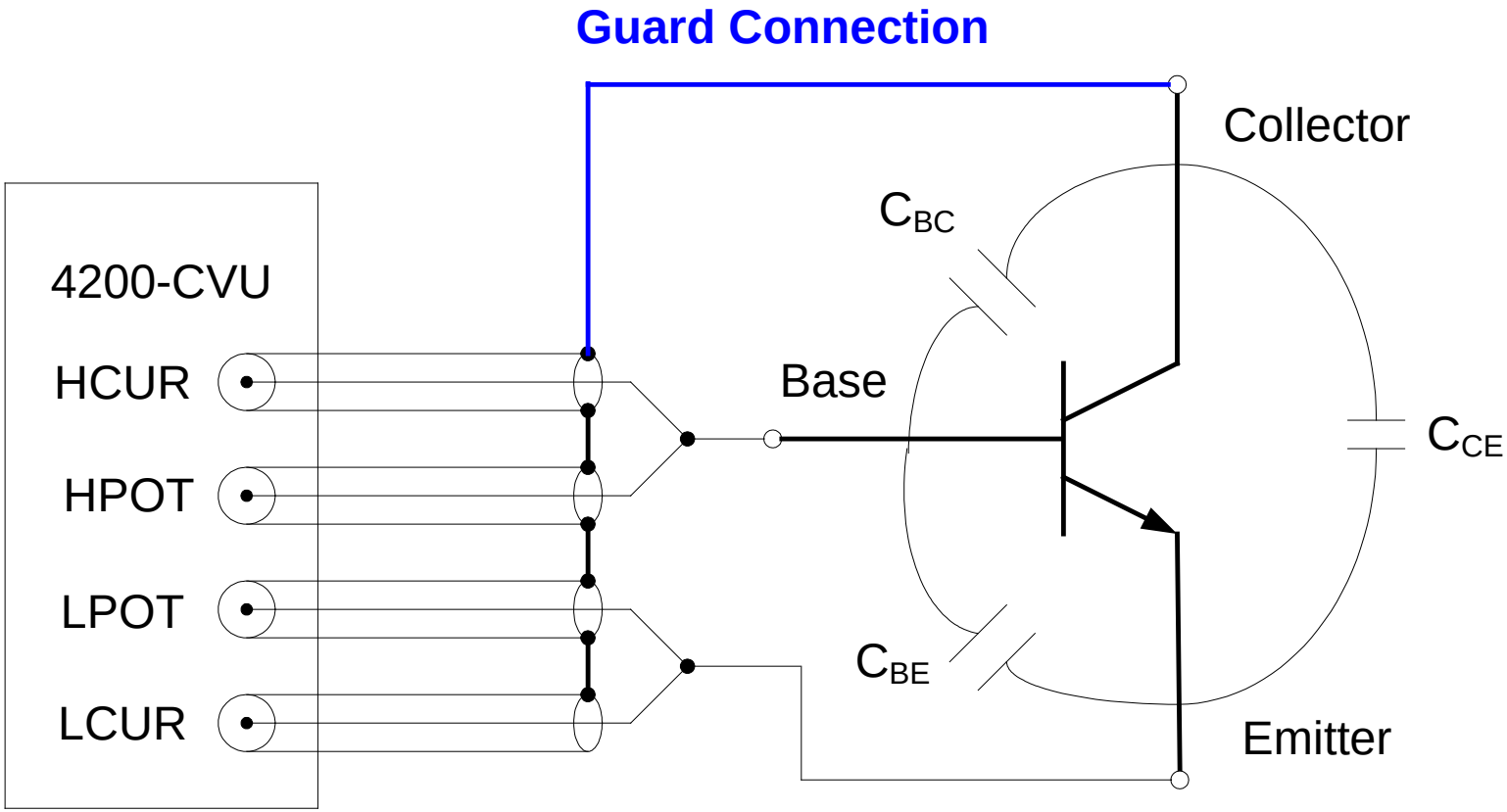
2

Guarding Stray Capacitance



With the Guard Connection, $C_{MEAS} = C_{BE}$.

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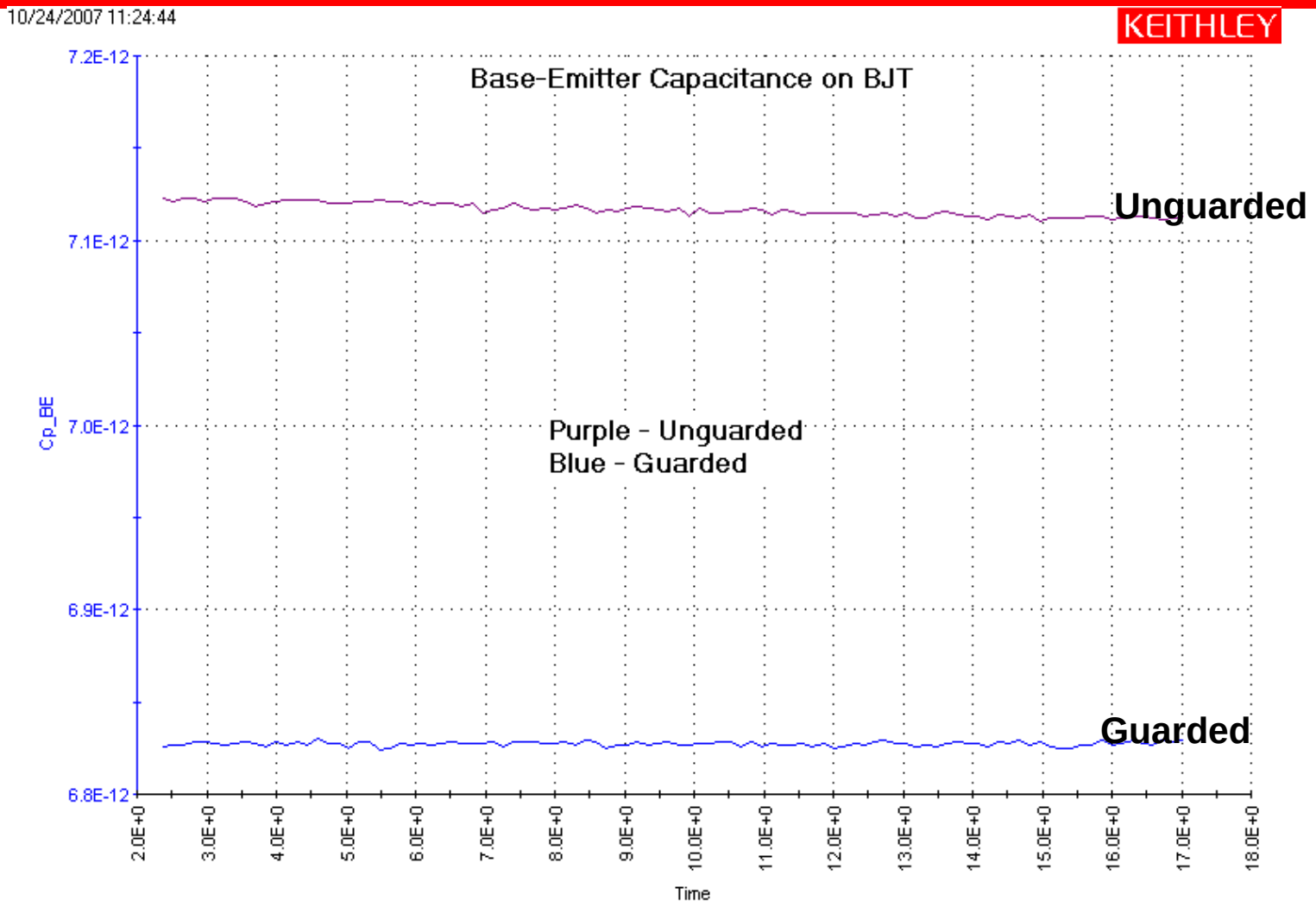
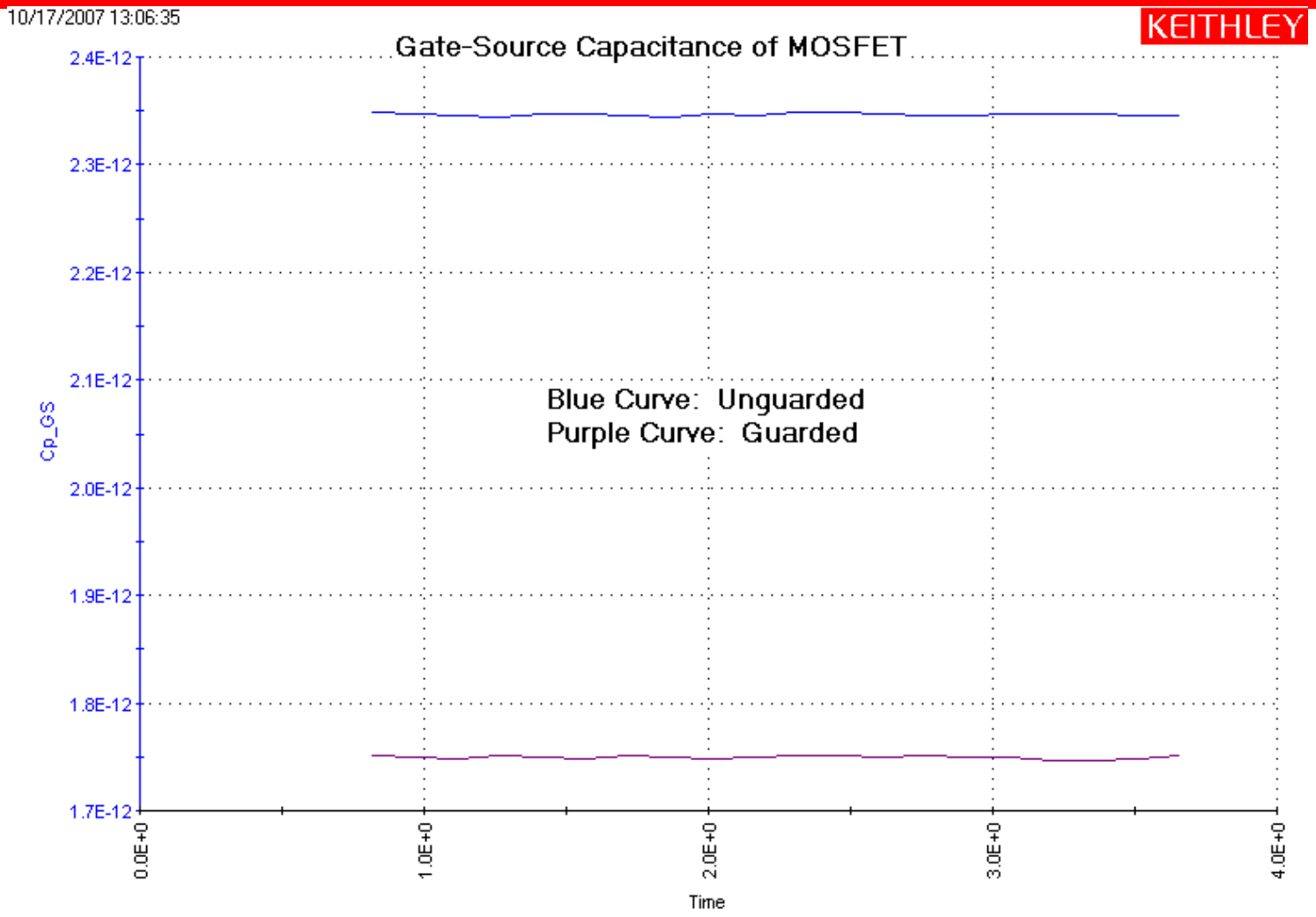
3

The Effects of Guarding on Measurement Accuracy

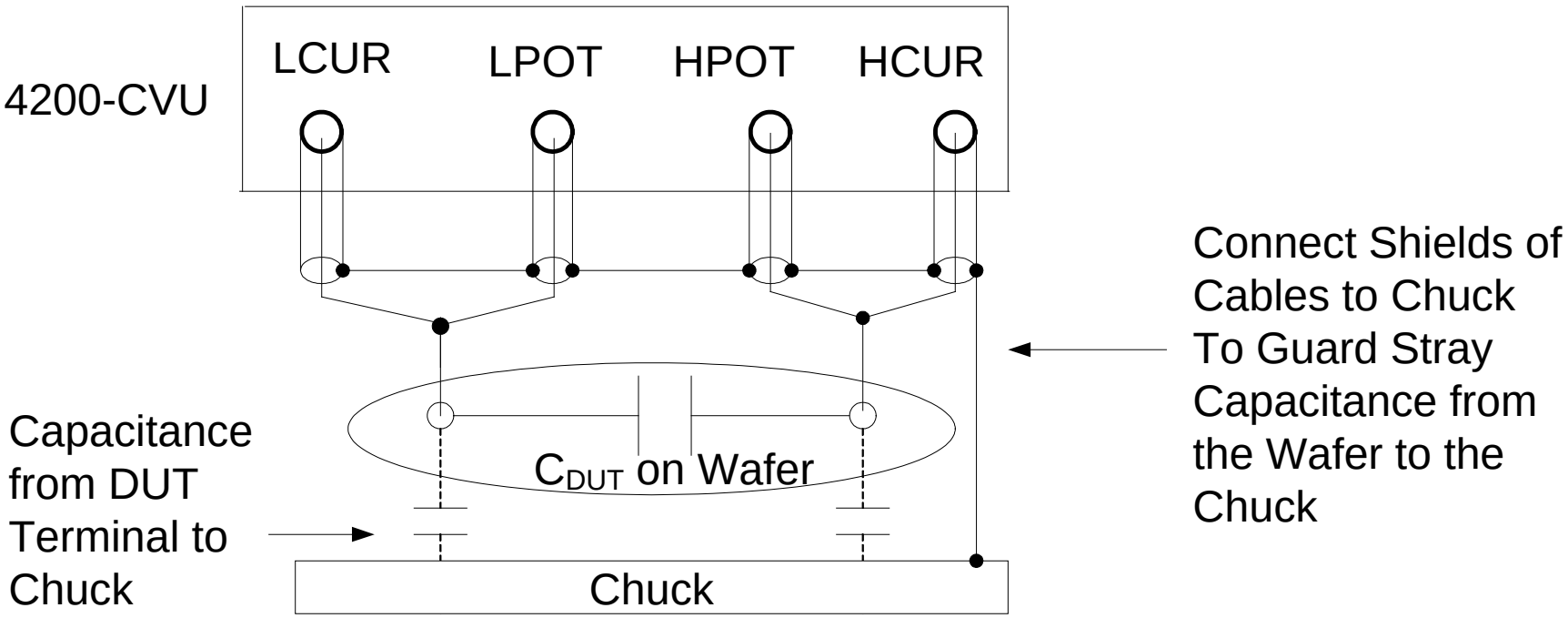


Guarding the Effects of Stray Capacitance on a MOSFET



5

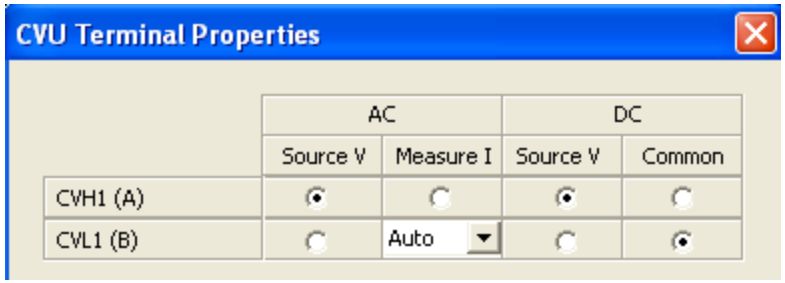
Guarding Measurements on a Wafer



Choosing the Optimal Connections

By default, the LCUR terminal is the AC Ammeter connection. The HCUR terminal is the DC Voltage Source terminal. However, the user has the option to change the function of the terminals in the Advanced Tab.

4200-CVU Terminals (Connections on rear panel of 4200)	AC	DC
HCUR	ACV Force	DCV HI Force
HPOT	ACV Sense	DCV HI Sense
LPOT	ACV Sense (0V)	DCV LO Sense
LCUR	ACI Measure	DCV LO Force (0V)



NOTE: CVH1 = HCUR and HPOT connected together
CVL1 = LCUR and LPOT connected together

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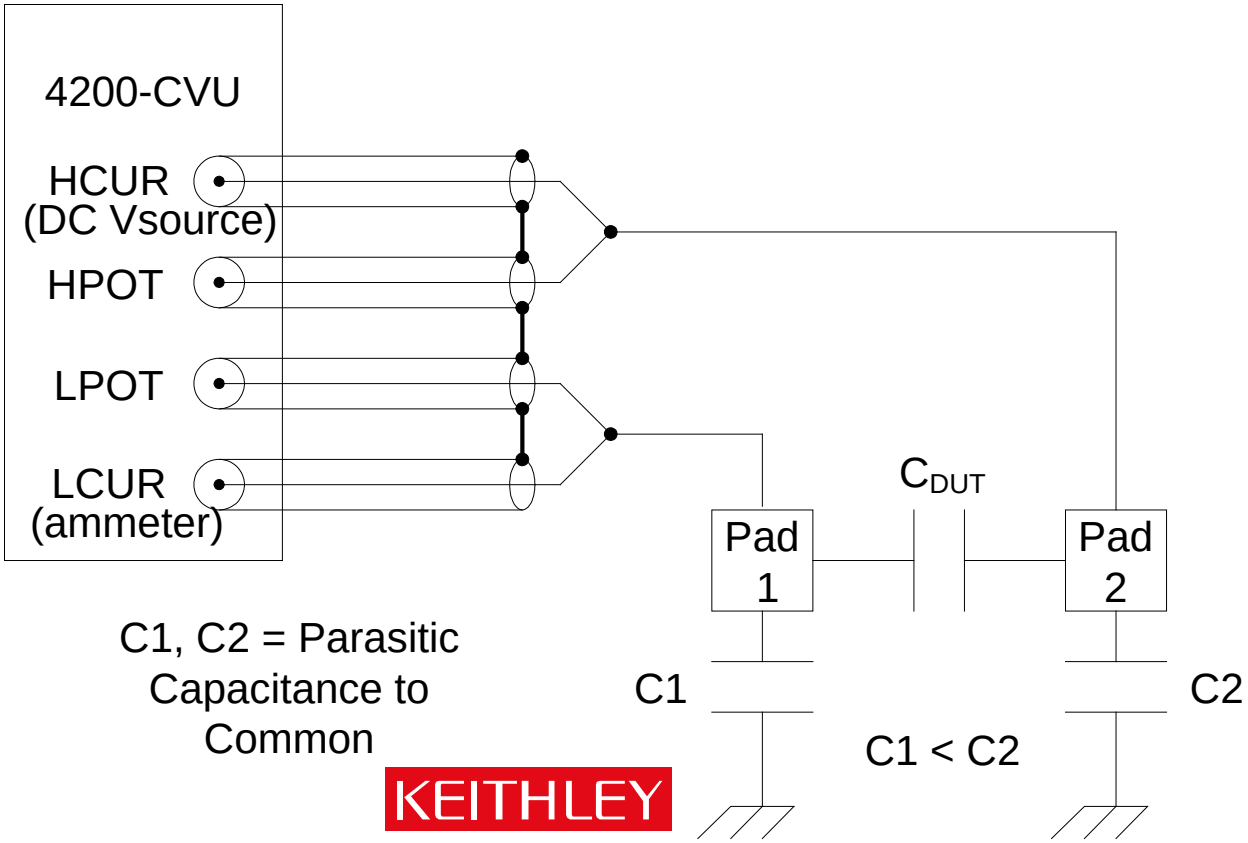
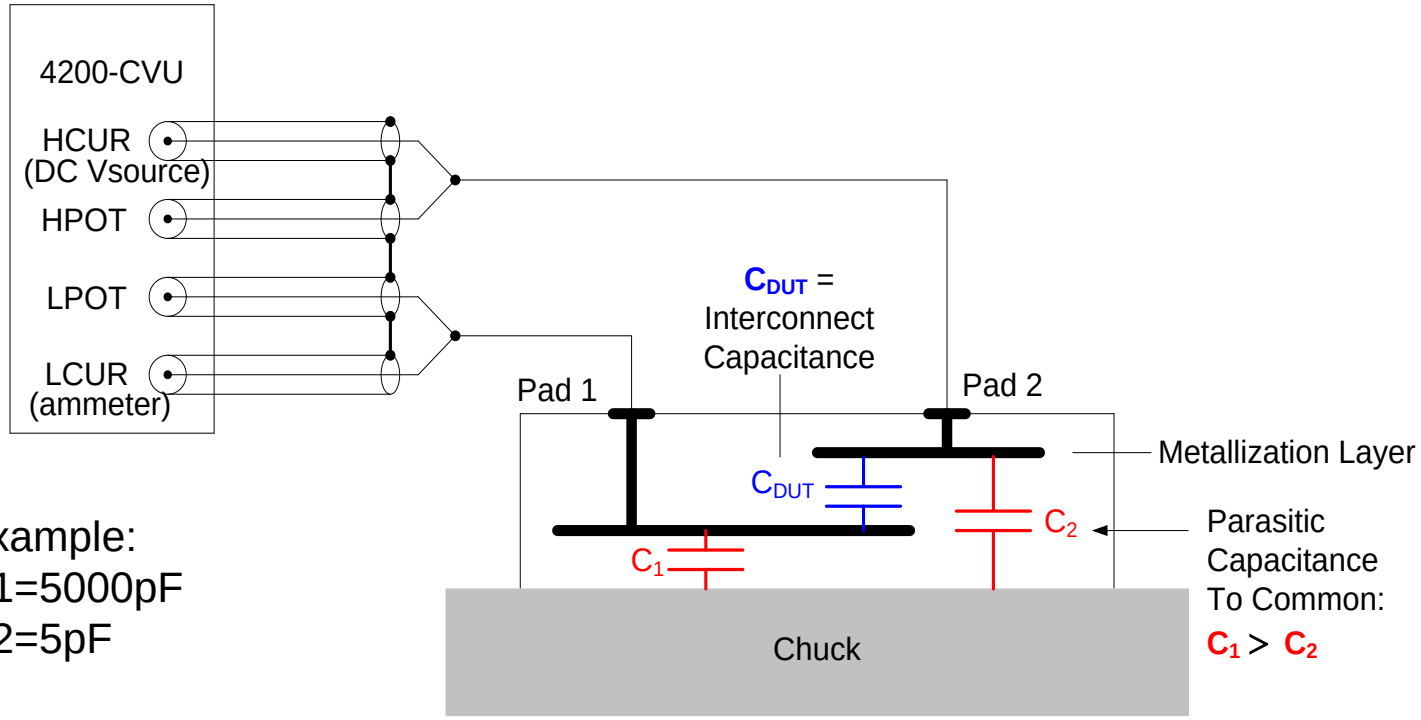
Connect the Ammeter to the Proper Terminal

To avoid noisy measurements and stray capacitance, the AC ammeter terminal should always be connected to the terminal of the device which has the least amount of capacitance to ground.



Example of Improper Connections

The AC Ammeter terminal should not be connected to the Pad which has greater capacitance to common! In many cases the user will not know which Pad has the greatest capacitance to ground. However, it is easy for the customer to reverse the leads in the Advanced Tab and repeat the measurement.

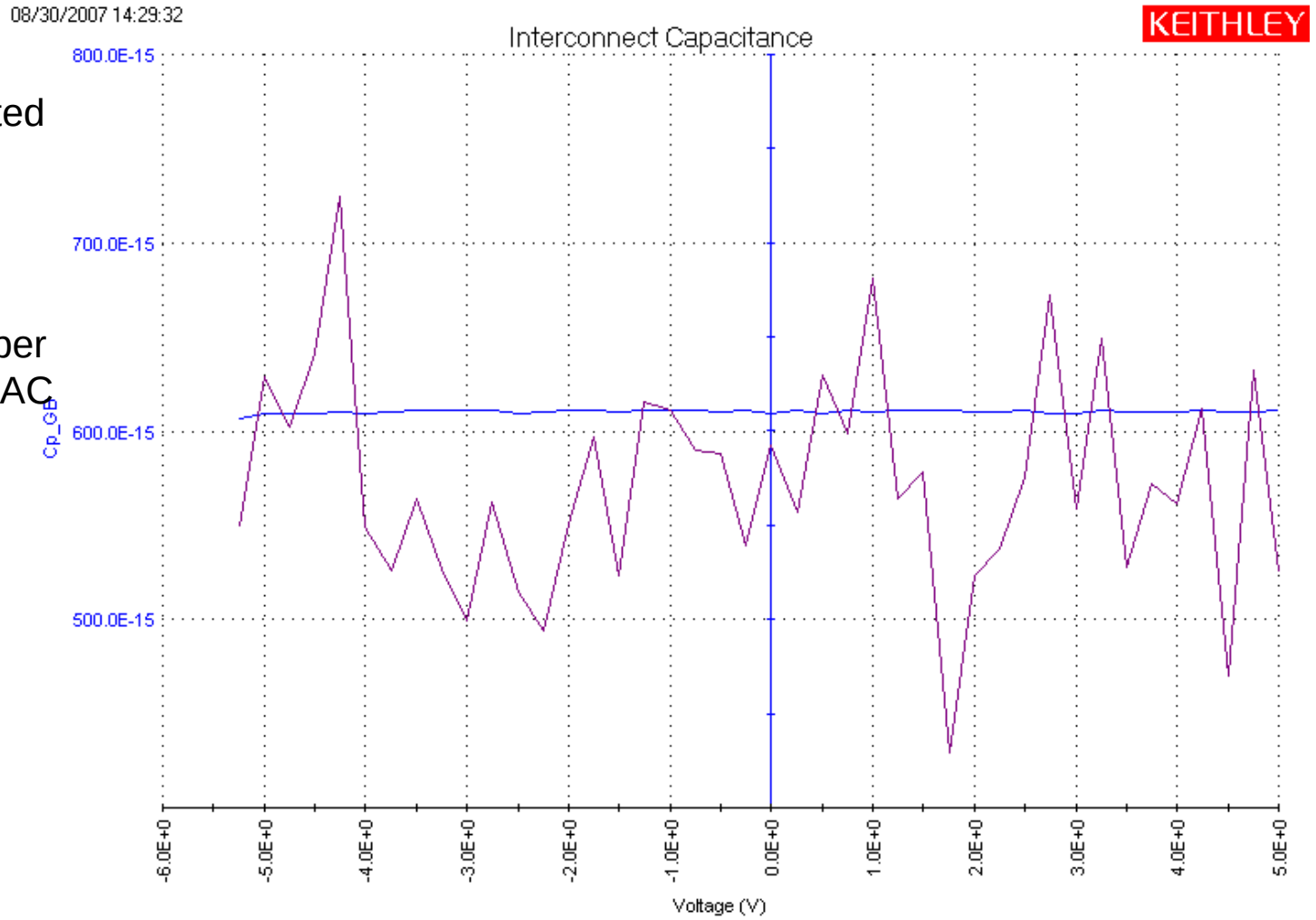


Example:
C1=5000pF
C2=5pF

Results of Proper and Improper Connections

Blue – Connected correctly – (AC Ammeter on Probe.)

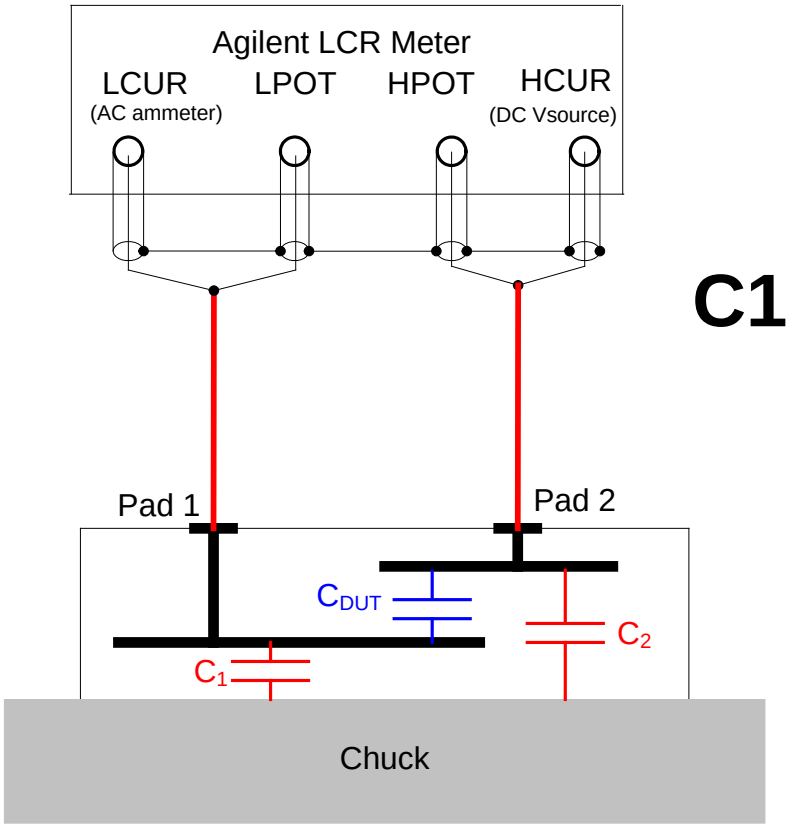
Purple – Improper connections – (AC Ammeter on Chuck.)



Connections with Agilent LCR Meter

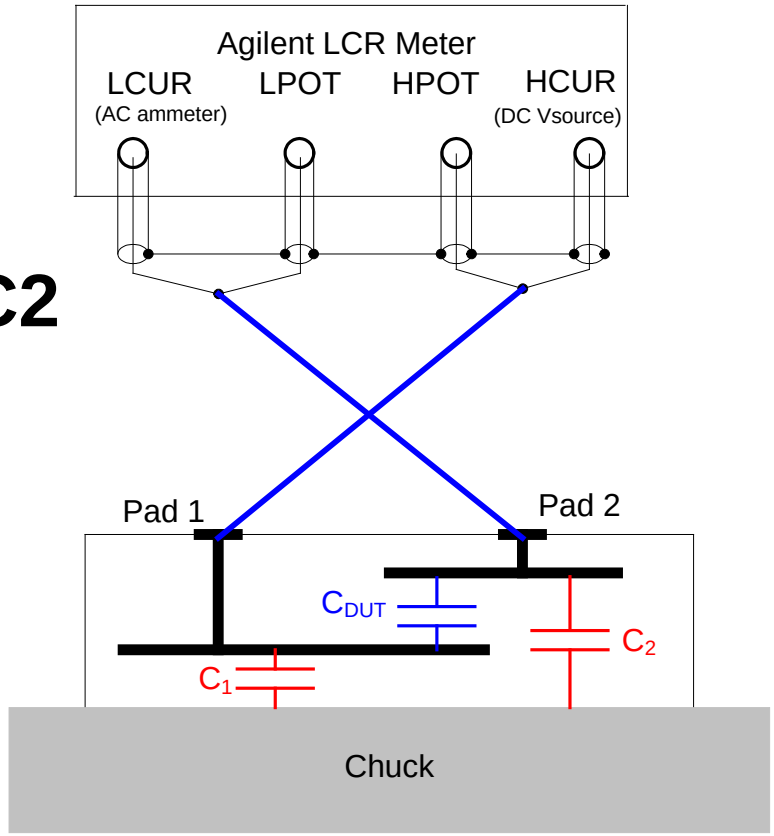
Using an LCR meter, the only way to correct the connections in this measurement is to physically reverse the leads! When you do this the DC bias is also reversed!

Improper



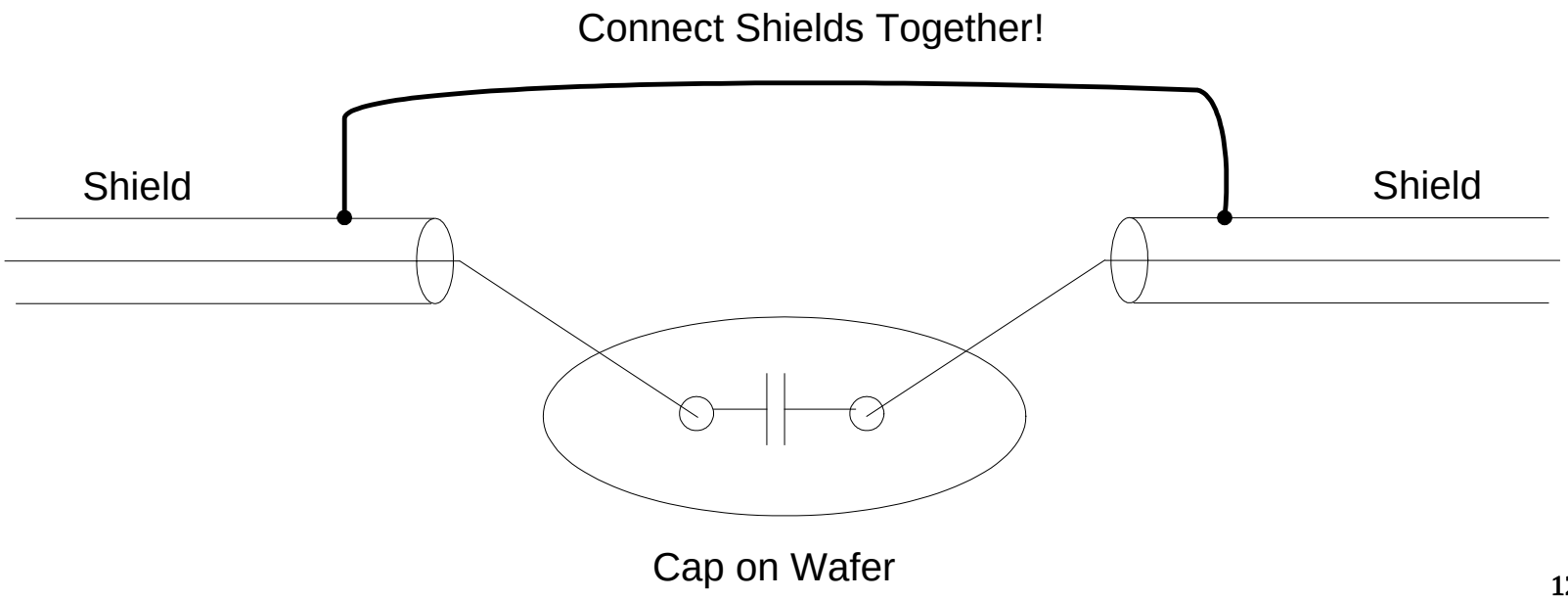
C1 > C2

Proper



The Importance of Shield Connections

Important Rule: Connect the shields of the coax cable together as close as possible to the DUT to avoid errors! This reduces the loop area of the shields which minimizes the inductance. This also helps to maintain the transmission line effects. If the shields are not connected together, large offsets may occur. The higher the frequency the more this becomes important.



12

Cabling Problems

Having appropriate cable length is crucial to making successful measurements. Inaccurate results occur with improper cabling. Here are some potential problems with cabling:

1) Improper cable length (mismatched length on different CVU terminals, length compensation incorrect)
2) Improper impedance (not using red cables)
3) Improper shield connections (not connected or not connected close enough to the DUT)
4) Bent, crimped or flattened cables (more critical at higher test frequencies)
5) SMA cable connectors not connected tight enough to test fixture (must be torqued to spec)