# FOUR KEY TESTS: Validating MOSFET Performance in Power Supply Designs

TEST SPECIFICATIONS

## Drain Family of Curves

**Definition:** Transistor output characteristics plotted as $I_{DS}$ versus $V_{DS}$ for several values of $V_{GS}$.

**Measurement Parameter:** $I_{DS}$ vs. $V_{DS}$

**Importance in Device Selection**: By looking at these curves, the designer can determine the best operating point for the application. At low drain-source voltages, the MOSFET behaves like a variable resistance whose value is controlled by the applied gate-source voltage. At higher drain-source voltages, the MOSFET passes a current whose value depends on the applied gate-source voltage. In most circuits, it is used in this 'high voltage' region and acts as a voltage-controlled current source.

### Test Technique:

1. Step the gate voltage ($V_{GS}$) across the desired range of values at specified increments.
2. At each $V_{GS}$ value, $V_{DS}$ is swept across the desired $V_{DS}$ range.
3. Measure the drain-source current ($I_{DS}$) at each $V_{DS}$ increment.

## Threshold Voltage

**Definition:** The minimum gate-to-source voltage differential required to produce current flow from the source to drain.

**Measurement Parameter:** $V_{TH}$

**Importance in Device Selection**: Threshold voltage is important for determining the on-state and the off-state of the MOSFET. $V_{GS(th)}$ is defined where $V_{DS} = V_{GS}$, although it is sometimes quoted for a fixed $V_{DS}$ (e.g. 10 V.)

### Test Technique:

1. Sweep the gate voltage ($V_{GS}$) while the drain-source voltage ($V_{DS}$) is set to a particular value.
2. Measure the drain current ($I_D$) at each value incremental of $V_{GS}$ in the sweep.
3. Determine the threshold voltage ($V_{TH}$) through a linear curve fit. A linear region on the curve is selected. The interception of the voltage axis gives the threshold voltage.

## Gate Leakage

**Definition:** Transistor gate leakage current as a function of the gate voltage.

**Measurement Parameter:** $I_G$ vs. $V_G$

**Importance in Device Selection**: The gate leakage current is important when calculating how much current is required to keep the device turned on. Because it is a leakage current through an insulator, this current is independent of temperature.

### Test Technique:

1. Sweep the gate voltage ($V_G$) over the desired range while the drain and source are tied to common.
2. Measure the gate current ($I_G$).

## Transconductance

**Definition:** The change in the drain current divided by the small change in the gate/source voltage with a constant drain/source voltage.

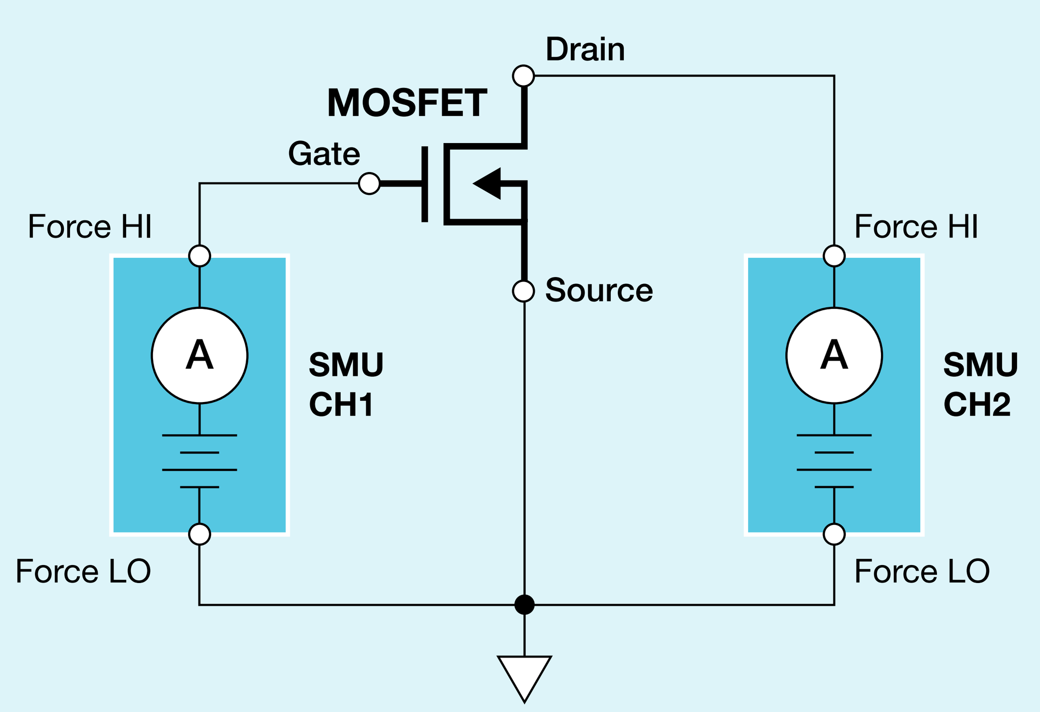
**Measurement Parameter:** $I_D$ vs. $V_{GS}$

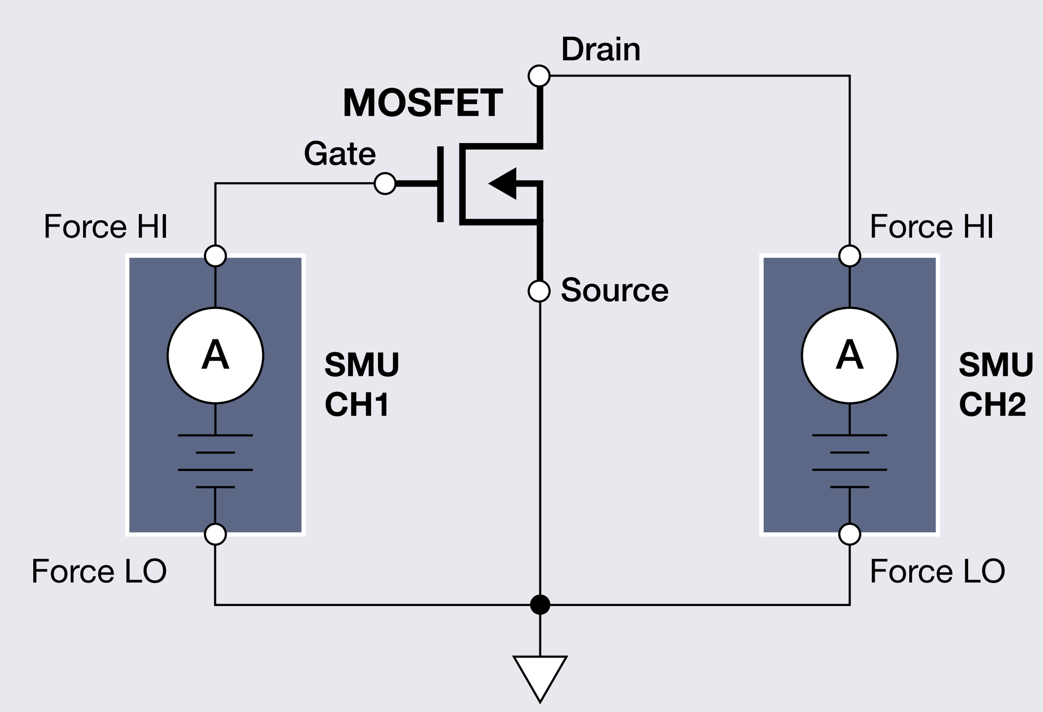
**Importance in Device Selection**: Transconductance helps the engineer to choose the best MOSFET with the right amount of gain (amplification) for the designs.

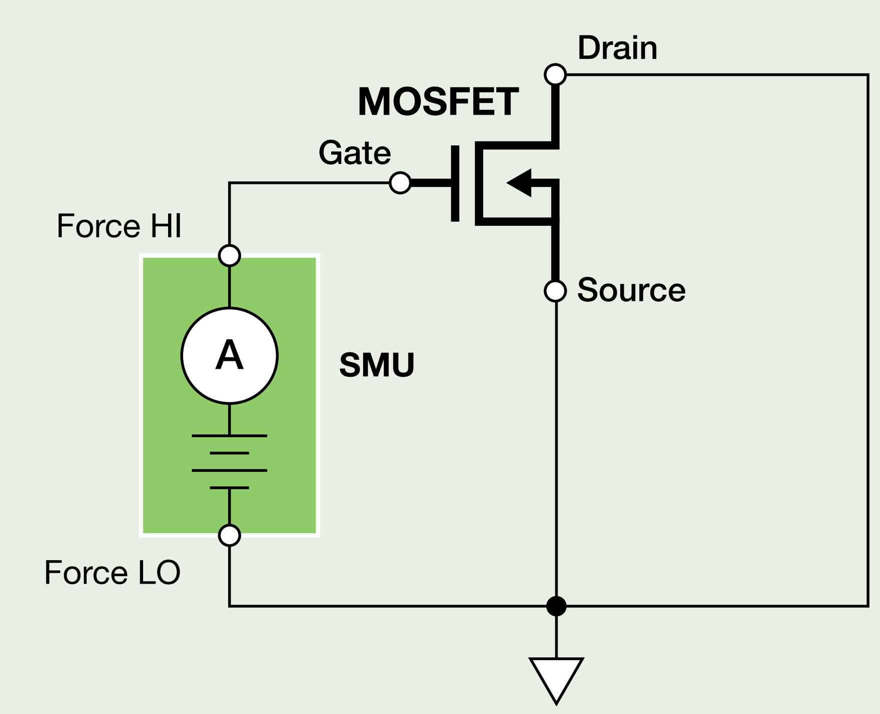
### Test Technique:

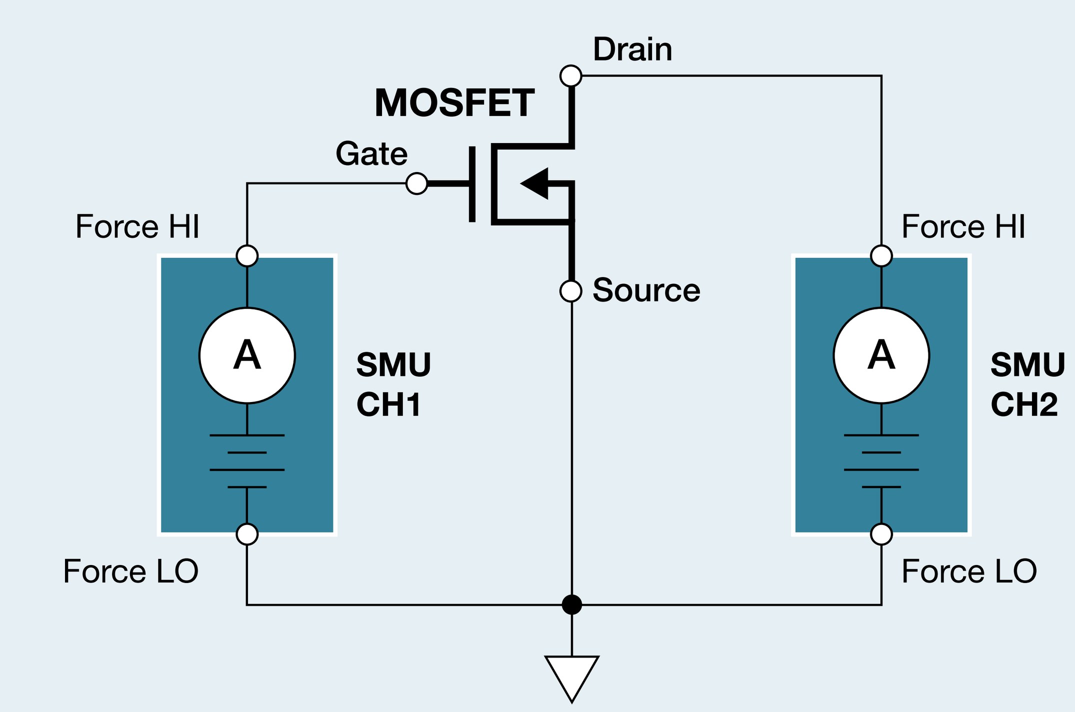
1. Sweep the gate voltage ($V_{GS}$) over the desired range, while maintaining a constant drain/source voltage ($V_{DS}$.)
2. Measure the drain current ($I_D$) at each increment step of $V_{GS}$.
3. Calculate transconductance ($g_m$) by dividing the small changes in $I_D$ by the small changes in VGS. $g_m = \Delta I_D / \Delta V_{GS}$.

TEST CONFIGURATION

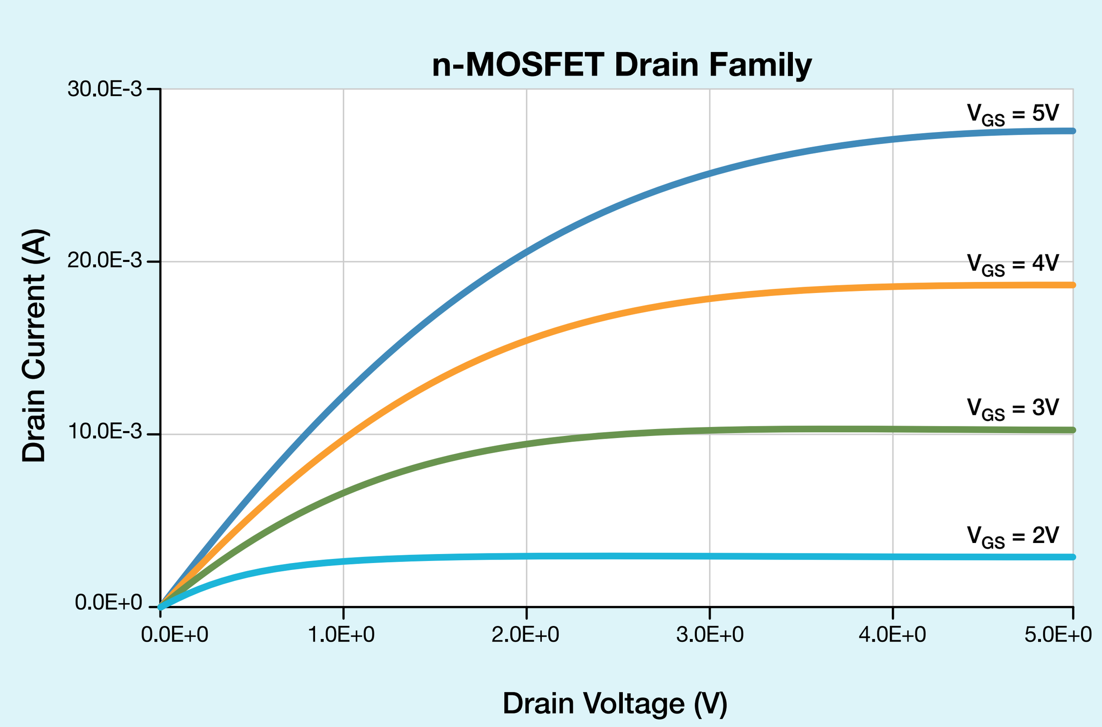


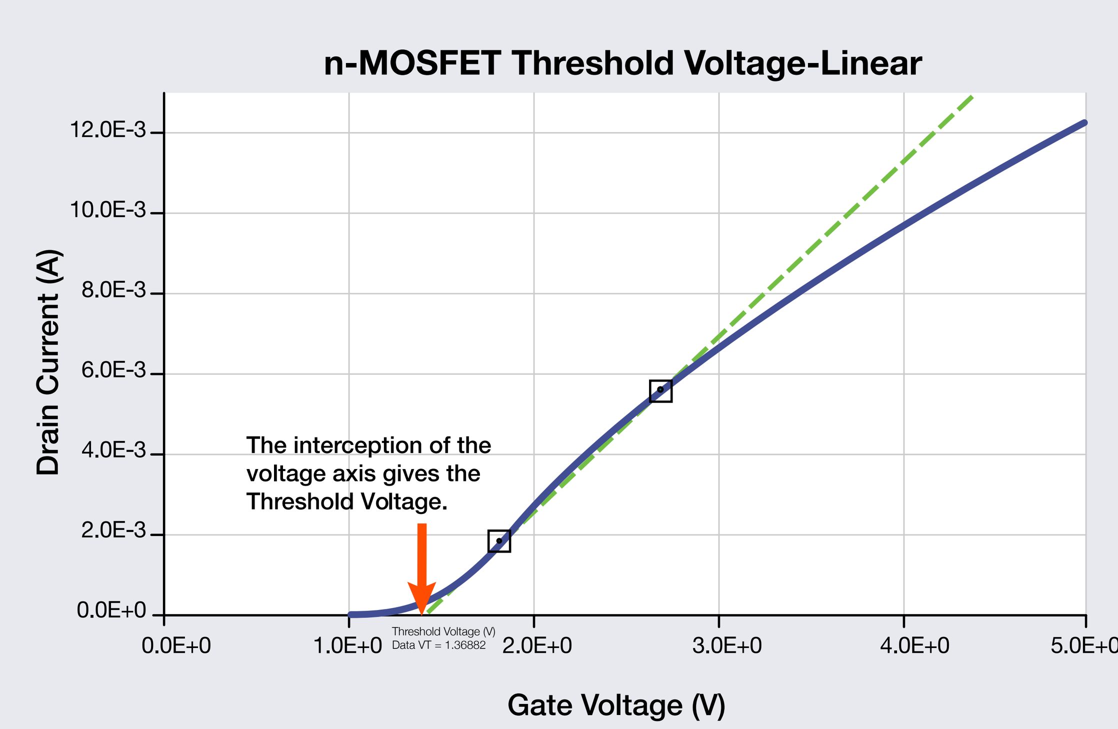



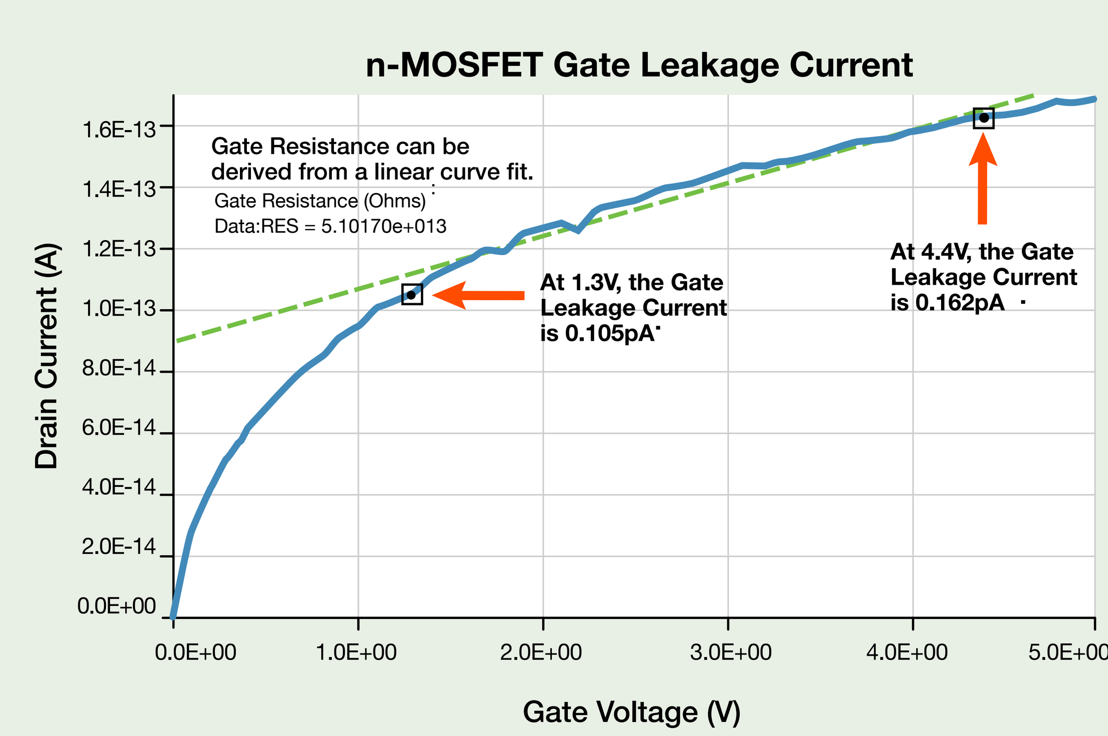



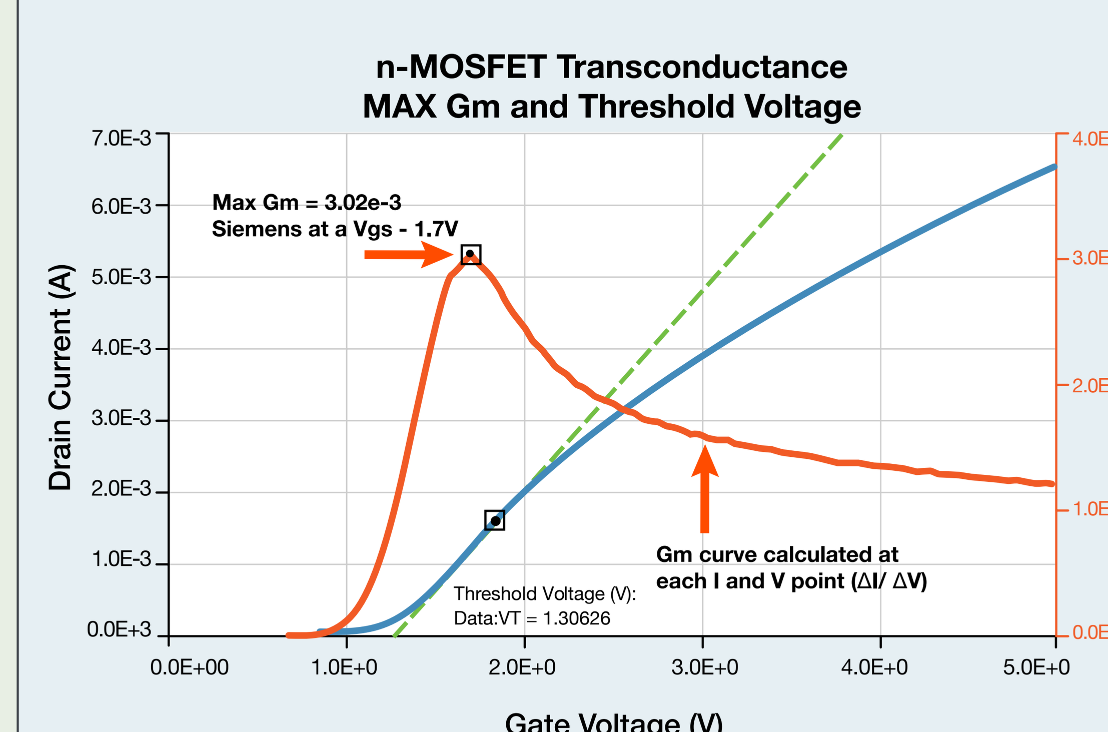




TYPICAL RESULTS





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