Accurate LTspice Model:

TOSHIBA provides accurate LTspice model for their power MOSFET products.

G0 & G2 models - Accuracy Clarification

SPICE Model grades	I_D-V_{DS}	C_{rss}-V_{DS}	C_{oss}-V_{DS}	C_{iss}-V_{DS}
G0 (RMS error criterion)	○ (10% or less)	× (Not applicable)	× (Not applicable)	× (Not applicable)
G2 (RMS error criterion)	○ (5% or less)	○ (2% or less)	○ (2% or less)	○ (2% or less)

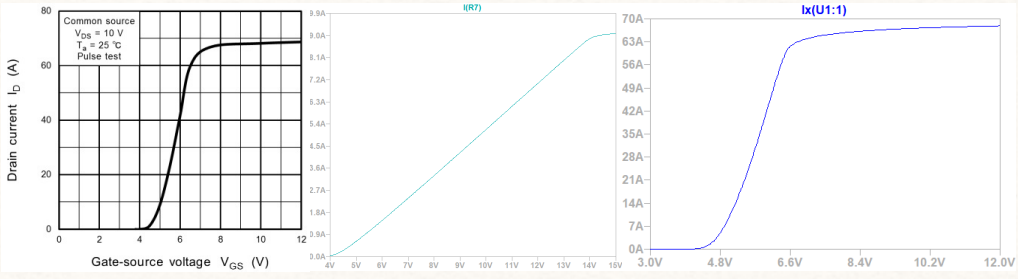
① G0
It is a standard device model based on BSIM3 and is a model with short calculation speed and suitable for function checking.

② G2
Compared with the G0 model, this model enhances the reproducibility of the high current region characteristics of I_D-V_{DS} curve and the voltage dependent characteristics of the parasitic capacitance, enabling highly accurate switching simulations that are closer to actual measurements.

Form website:

https://toshiba.semicon-storage.com/ap-en/semiconductor/knowledge/highlighted-contents/articles/simulating-the-transient-characteristics-of-mosfet-more-accurately/simulating-the-transient-characteristics-of-mosfet-more-accurately-download.html

Device select: Silicon N-Channel MOSFET (DTMOSVI) TK110A65Z: Rds_on = 0.092Ω typical & Vds_max = 650 V & Id_max = 24A & Pd_max = 45 W



It provides .asy file (LTspice Symbol File), just copy it into LTspice library file direction. (LTspiceXVII\lib\sym)

LTspice simulation 1: The MOSFET characteristic curve from simulation does not match the data sheet.

TK110A65Z - Id vs Vgs curve when Vds =10V: At Vgs = 6V, Id should be around 40A but the simulation only shows 1.3A.

There are pspice models that provided in TOSHIBA too.

Pspice and spice model difference:

PSPICE is a proprietary circuit simulator provided by OrCAD. While some PSPICE models are compatible with SPICE, there is no guarantee.

TOSHIBA Clarification: Operation of this model has been verified only on the PSpice (OrCAD 17.2).

OrCAD - circuit simulation and PCB design - can be used later when the simple test circuit is verified in LTspice.

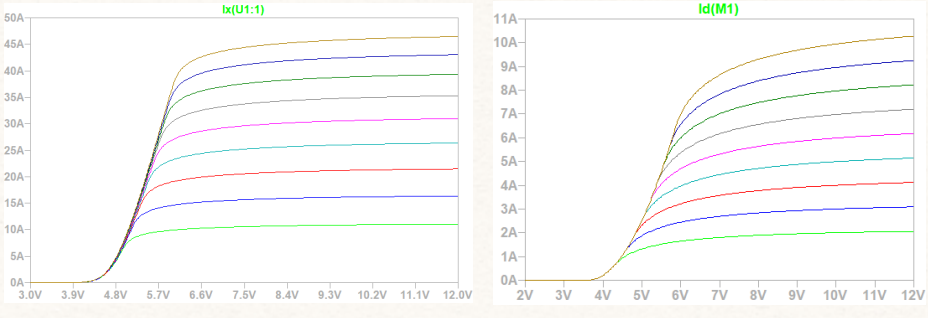
LTspice Simulation 1 mistake: set Rshunt too big = 1Ω, which draw down the current flow ability for the MOSFET.

The MOSFET characteristic curve from simulation extremely matches the data sheet.

TK110A65Z - Remove Rshunt to avoid any effect on MOSFET performance.

Id vs Vgs curve when Vds =10V: At Vgs = 6V, Id is around 40A; At Vgs = 10, Id is around 67A.

TK110A65Z is better than CDM7-700LR, because it has higher current when Vds = 1~4V, and requires less gate voltage (<10V).



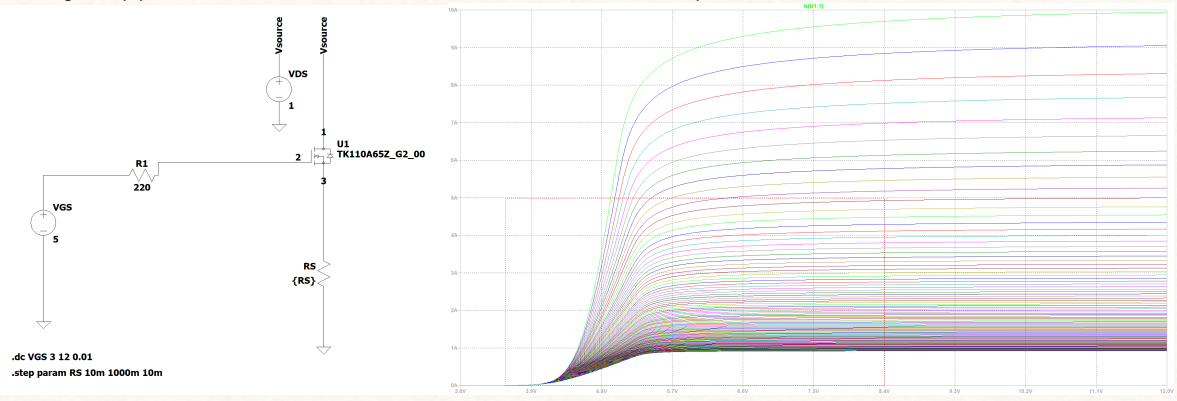
The figures above show the curves of Id vs Vgs for different Vds (.dc Vgs = 3~12V by 0.01V & Vds = 1~5V by 0.5V)

As we can see for TK110A65Z (Right) at 1~5 Vout from the converter, it can achieve > 5A drain current by just increase Vgs.

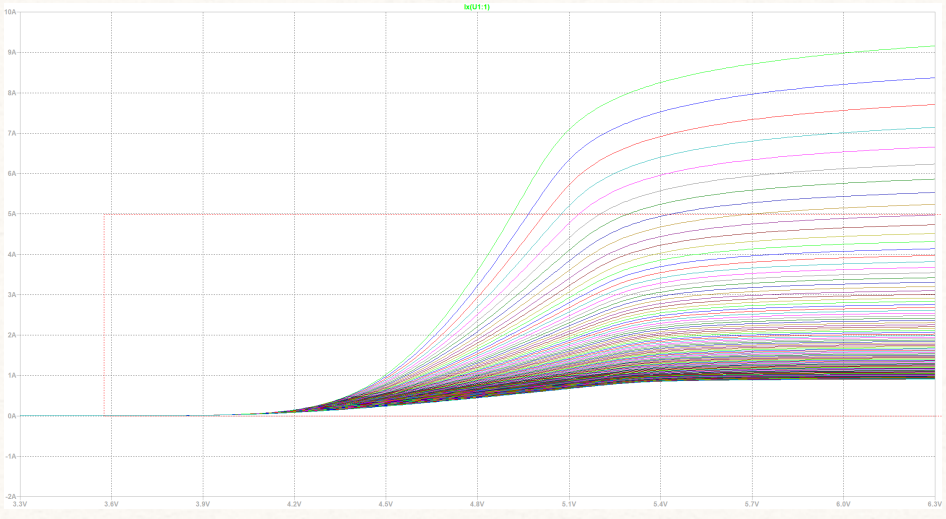
While for CDM7-700LR (Left), it cannot achieve 5A until Vds reaches > 3V.

TK110A65Z : Rshunt Value Analysis:

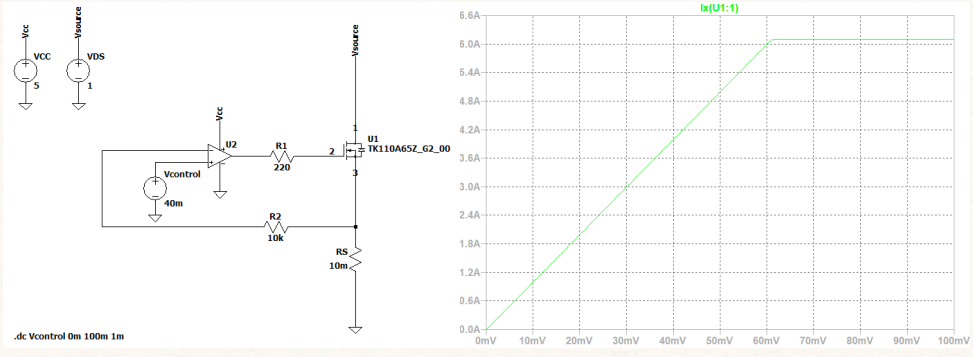
Vds minimum 1V; Id range 0~5A; check Rshunt value with Vgs range 3~12V;
Id vs Vgs (.step param RS 10m 1000m 10m) Rs vary from 10mΩ to 1Ω by 10mΩ step.



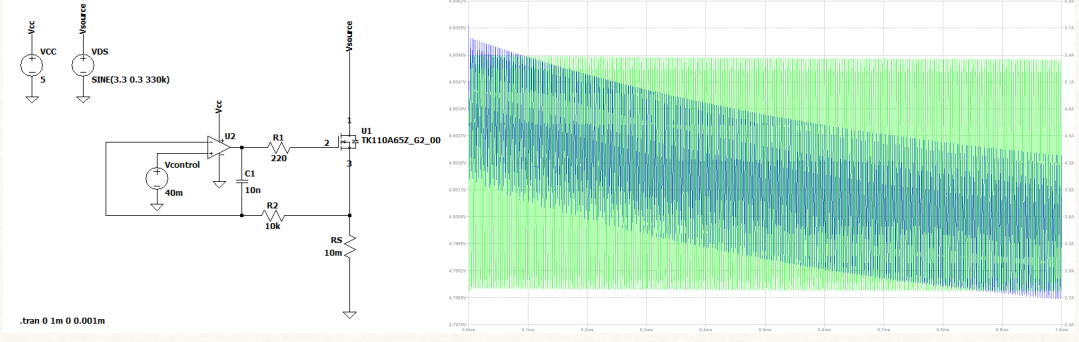
The figure shows when Rshunt is added, how much Vgs is required for the MOSFET to give Id = 0~5A.
Set a red square of 3.6V~8V & 0~5A, because we want small range of Vgs to control the MOSFET to vary from 0~5A or even > 5A
For example, Vgs range is 0~6V, only 10mΩ~50mΩ Rshunt support Id vary full range from 0~6A.



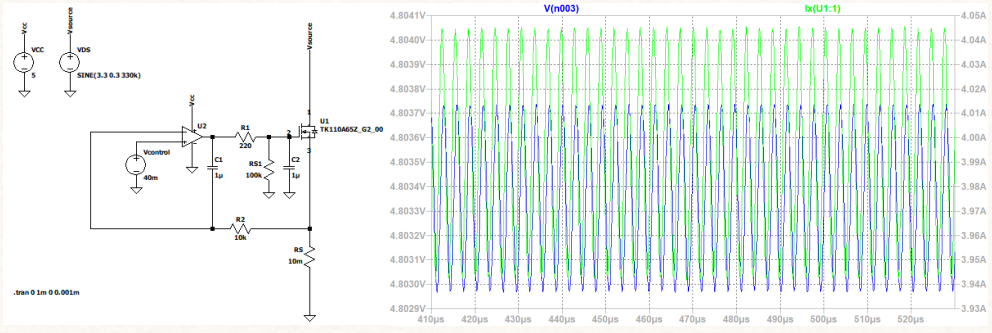
TK110A65Z : Op-Amp Analysis:



By varying Vcontrol, the load current can vary from 0~6.1A, where MOSFET acts as a resistance variable element.



Add one capacitance to filter out some high-frequency noise; Set Vsource as sine wave to imitate converter output ripple.
Output current & Vgs show above. This results are not good since current vary from 2.7~5.4A when the reference is set as 4A.



Add RC filter at Vgs to avoid severe voltage oscillation, in order to avoid large oscillation at load current.
This results become better, load current vary from 3.94~4.05A when the reference is set as 4A.
-> RC filter works, and the value of RC filter should be carefully calculated afterwards.