Qspice - Model Generators Guide by KSKelvin

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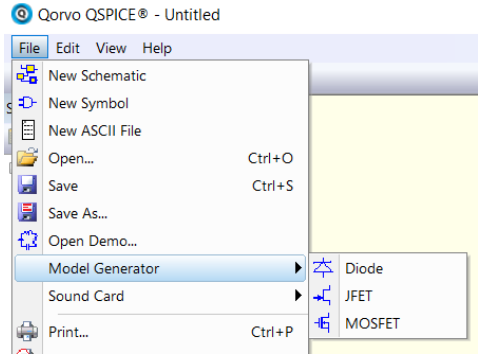
Model Generator and Precaution in using this Guide

- Model Generator
  - Model generators are in File > Model Generator > Diode/JFET/MOSFET
  - Execute one of these model generators, within the subprogram, it has official HELP

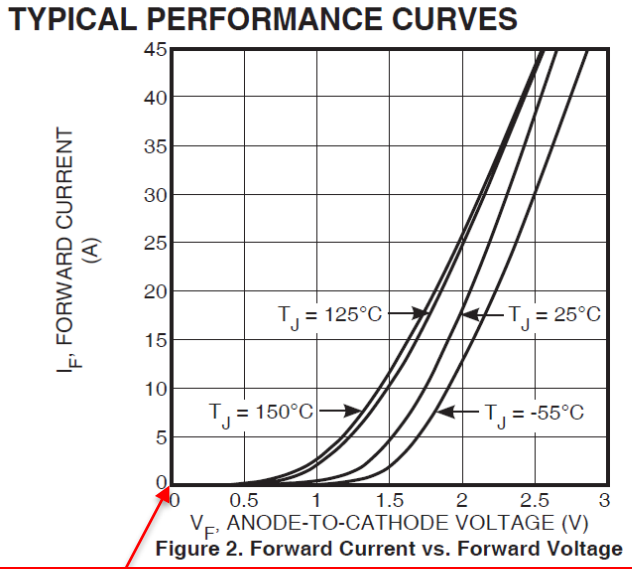


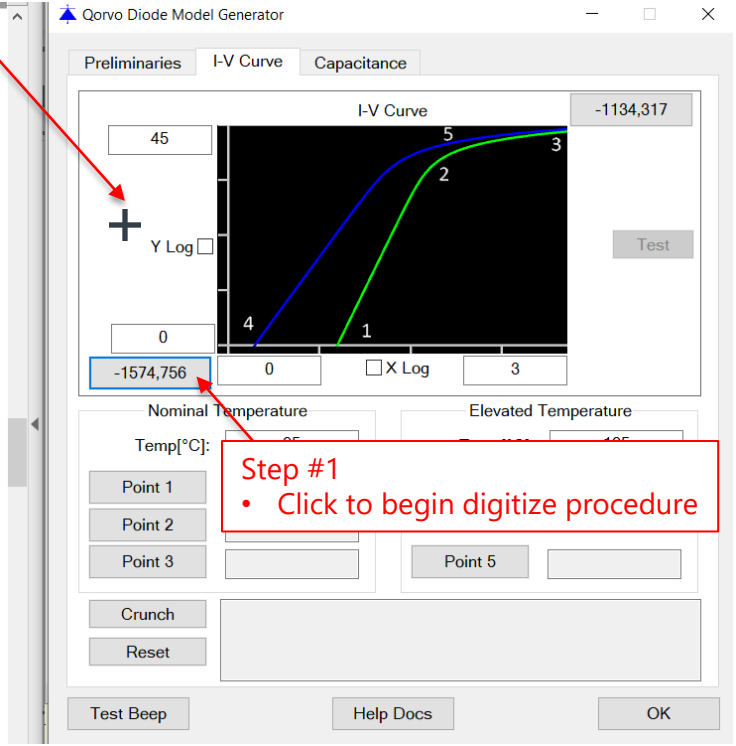
- Precaution in using this Guide
  - The model generator appears to still be subject to change. If you are unable to replicate the example provided in this guideline, it may be related to a change in the model generator
  - I cannot guarantee the accuracy of this guideline as it heavily relies on parameter studies through these model generators. This guideline is still in its preliminary status

Technique in Digitizing Datasheet

Digitize with Crosshair Cursor and Arrow Slight Adjustment

Step #2 : **[Crosshair Cursor]**
- Move cursor to this area, **hold** Left mouse button
  Now, the cursor become a crosshair



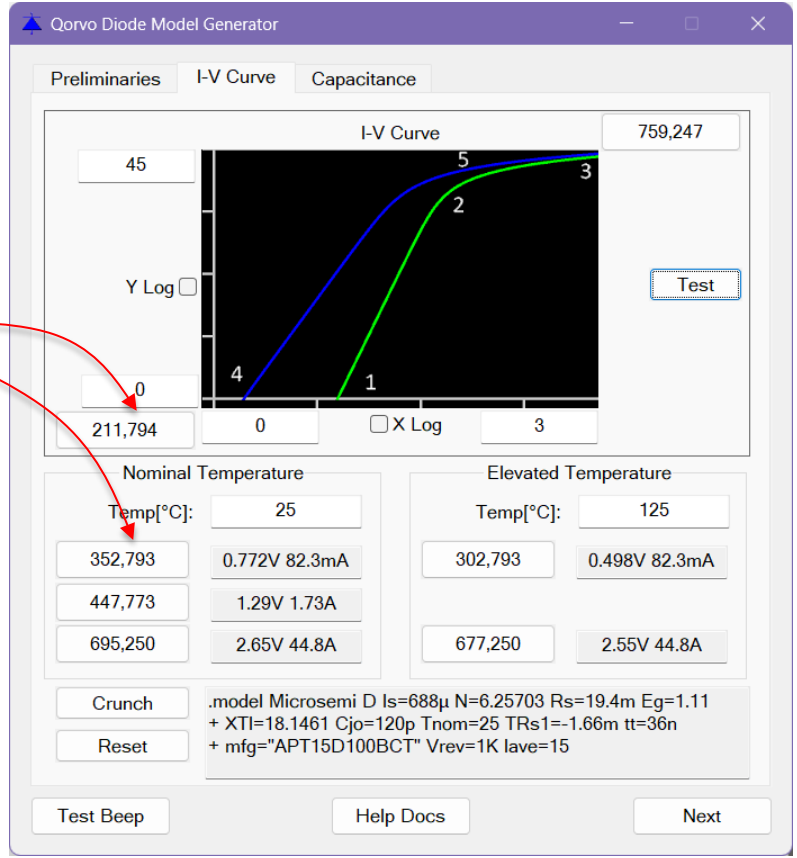


Step #1
- Click to begin digitize procedure

Step #3 :
- Move crosshair cursor to pdf to digitize lower left corner
  (Can **use arrow key to adjust crosshair position precisely**)
- Release left mouse button and location is digitized
- [Repeat Step #2 and #3 until all points is digitized]

Useful Technique in using Digitize

To digitize a very small value on a linear scale, use the arrow keys to make fine adjustments to the cursor. Monitor the y-axis value to ensure it is one digit less than the y-axis value of the LowerLeft.



Diode Model Generator

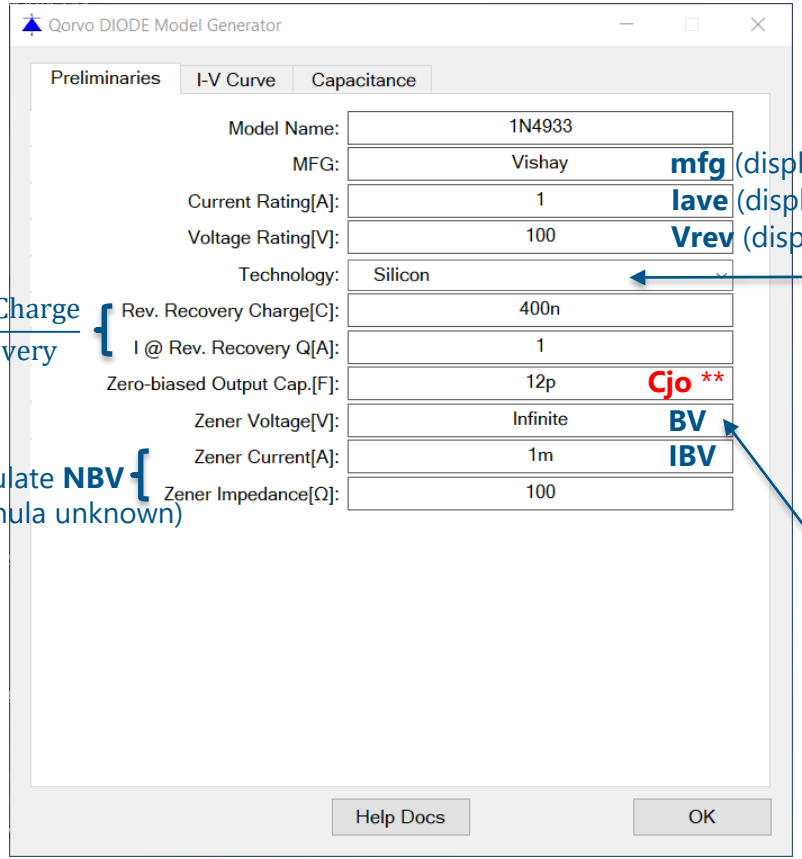
DIODE.exe

Diode Model Generator

Parameters Generation

Diode Model Generator – Preliminaries Tab

Determine : mfg, Iave, Vrev, Eg, tt, Cjo**, BV, IBV, NBV



mfg (display only)

Iave (display only)

Vrev (display only)

Cjo **

BV

IBV

$$tt = \frac{\text{Rev Recovery Charge}}{\text{I @ Rev Recovery}}$$

Calculate **NBV** (formula unknown)

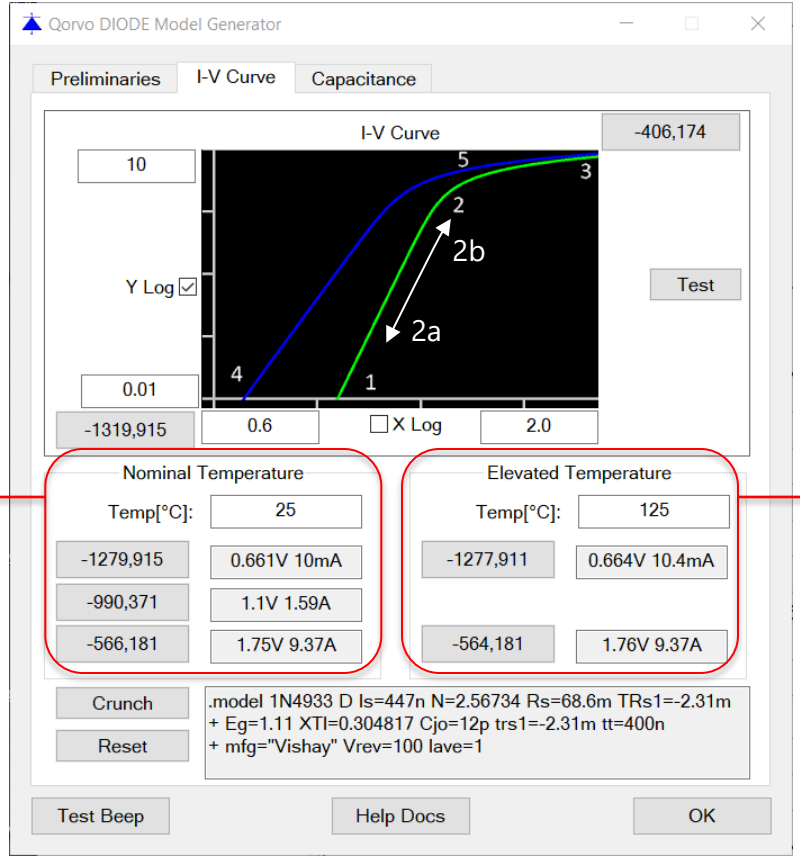
Silicon	**Eg** = 1.11
Schottky Barrier Diode	**Eg** = 0.69
Germanium	**Eg** = 0.67
Gallium Nitride(GaN)	**Eg** = 3.47
Siconon Carbide(SiC)	**Eg** = 3.26
Gallium Arsenide(GaAs)	**Eg** = 1.42

BV, **IBV**, **NBV** will be generated if this box is non-zero

Cjo : This only determine Cjo in I-V Curve digitized tab. If Capacitance digitized tab is used, this Cjo will be ignored

Diode Model Generator – I-V Curve Tab

Determine : Is, N, Rs, TRs1, XTI



Determine **Is**, **N**, **Rs**

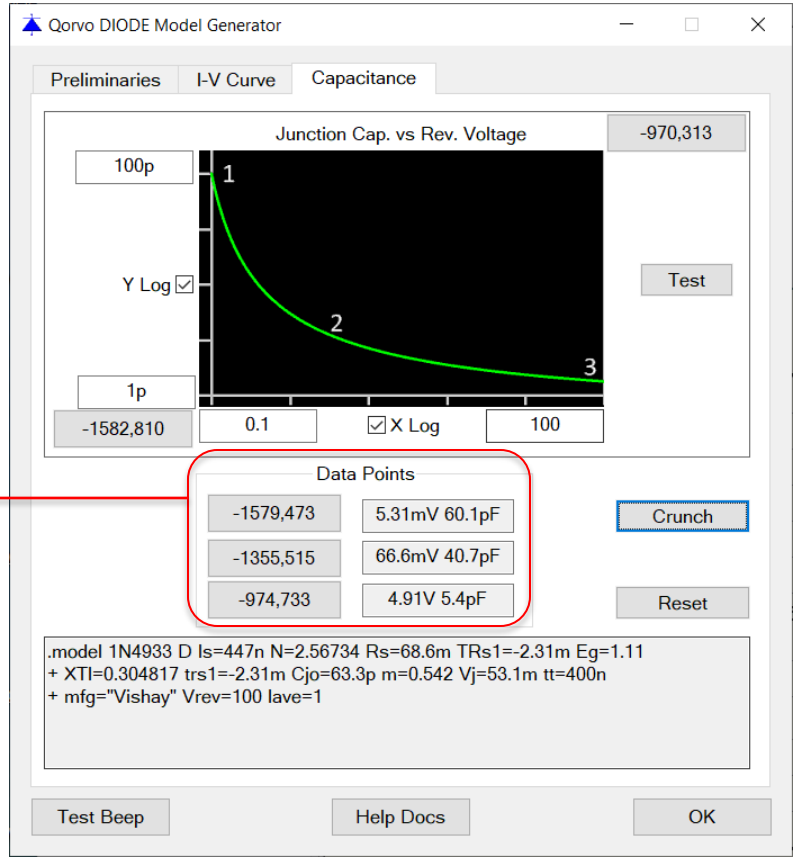
Determine **TRs1, XTI**
If Temp set to be identical nominal temperature, force TRs1=0 and XTI=3
(If XTI=3, TRs1 may not generated)

** where to digitize point #2 can affect Is and N
If point #1 and #2 are closer (e.g. at #2a), Is tends to be calculated smaller

Diode Model Generator – Capacitance Tab

Determine : Cjo, m, Vj

Determine **Cjo**, **m** and **Vj**



Diode Model Generator

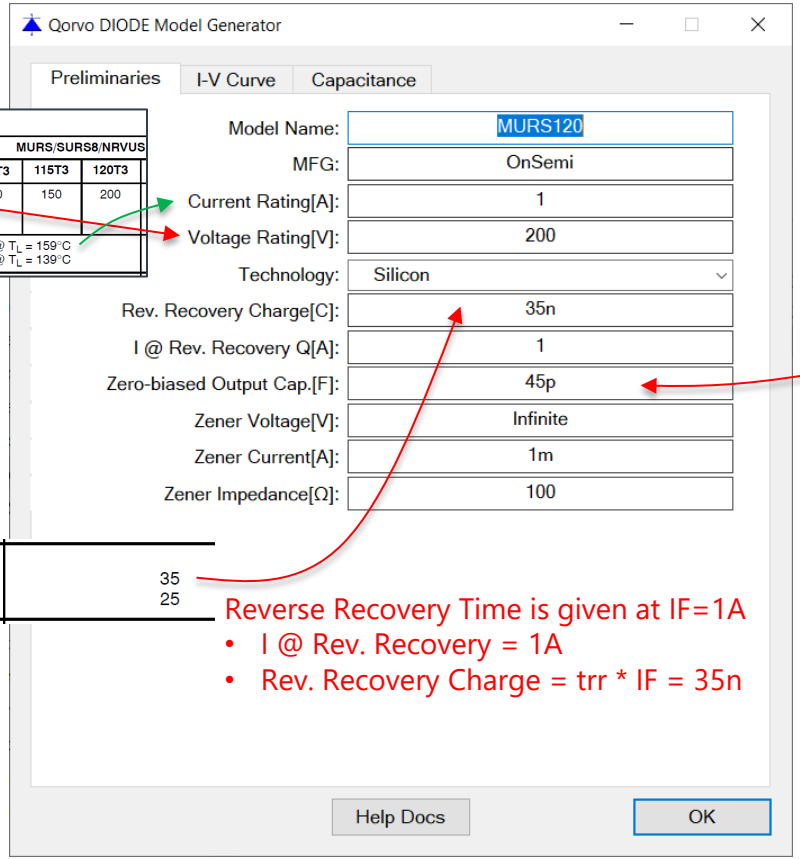
Example – Datasheet of Onsemi MURS1200

Example – Onsemi MURS120 Datasheet to Model Generator

MAXIMUM RATINGS

Rating	Symbol	MURS/SURS8/NRVUS 105T3	110T3	115T3	120T3
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200
Continuous Forward Current	$I_{F(DC)}$	1.0 @ T_L = 159°C 2.0 @ T_L = 139°C			

Maximum Reverse Recovery Time (I_F = 1.0 A, di/dt = 50 A/μs, V_R = 30 V) (I_F = 0.5 A, i_R = 1.0 A, I_R to 0.25 A)	t_{rr}	35 25



Reverse Recovery Time is given at IF=1A

- I @ Rev. Recovery = 1A
- Rev. Recovery Charge = trr * IF = 35n

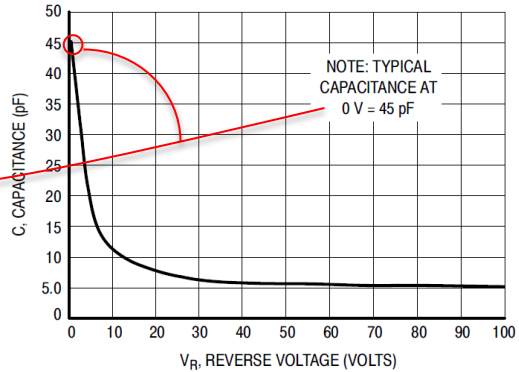


Figure 3. Typical Capacitance

Example – Onsemi MURS120 Datasheet to Model Generator

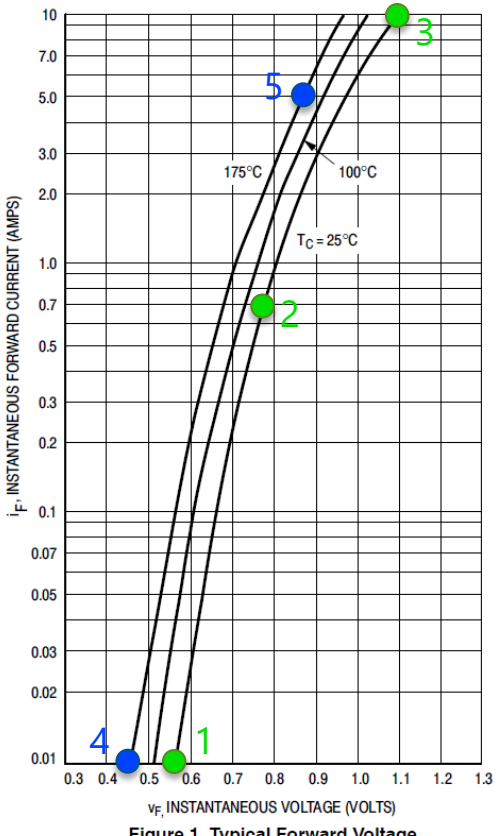
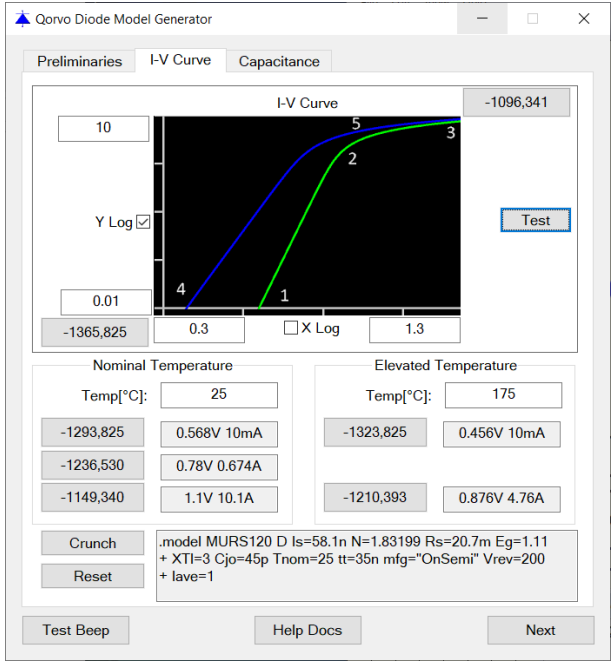
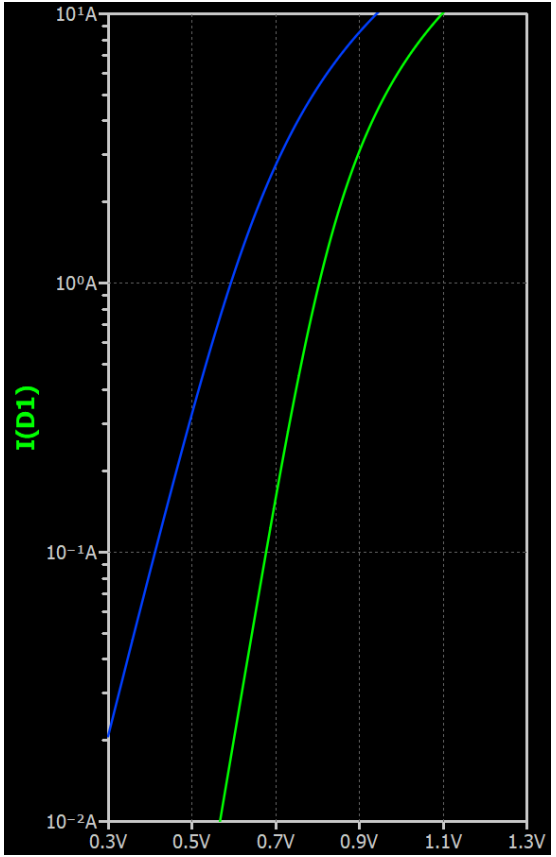


Figure 1. Typical Forward Voltage





Example – Onsemi MURS120 Datasheet to Model Generator

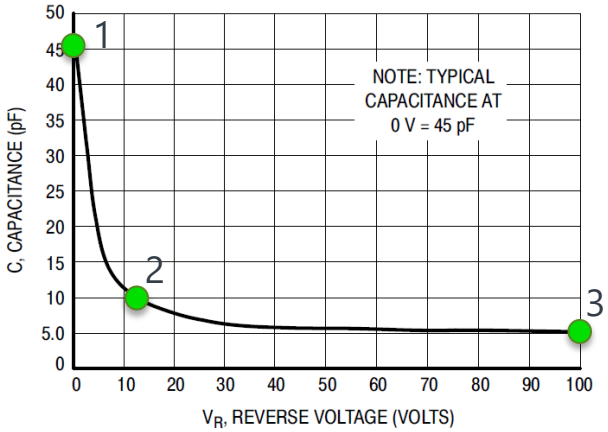
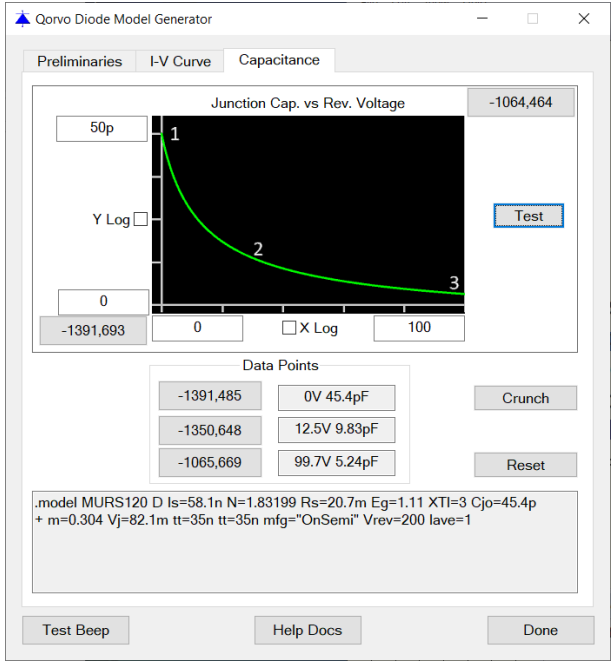
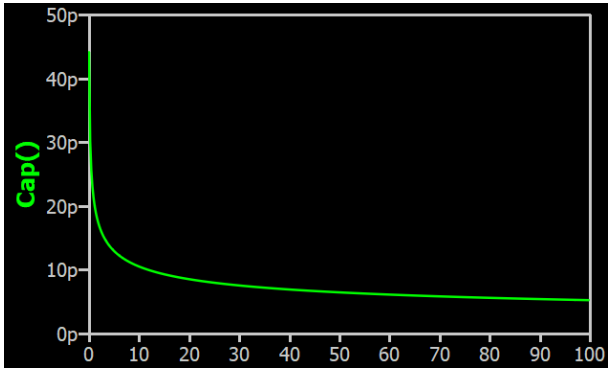


Figure 3. Typical Capacitance





Diode Model Generator

Example – Datasheet of Microchip APT15D100BCT

Example – Microchip APT15D100BCT Datasheet to Model Generator

MAXIMUM RATINGS

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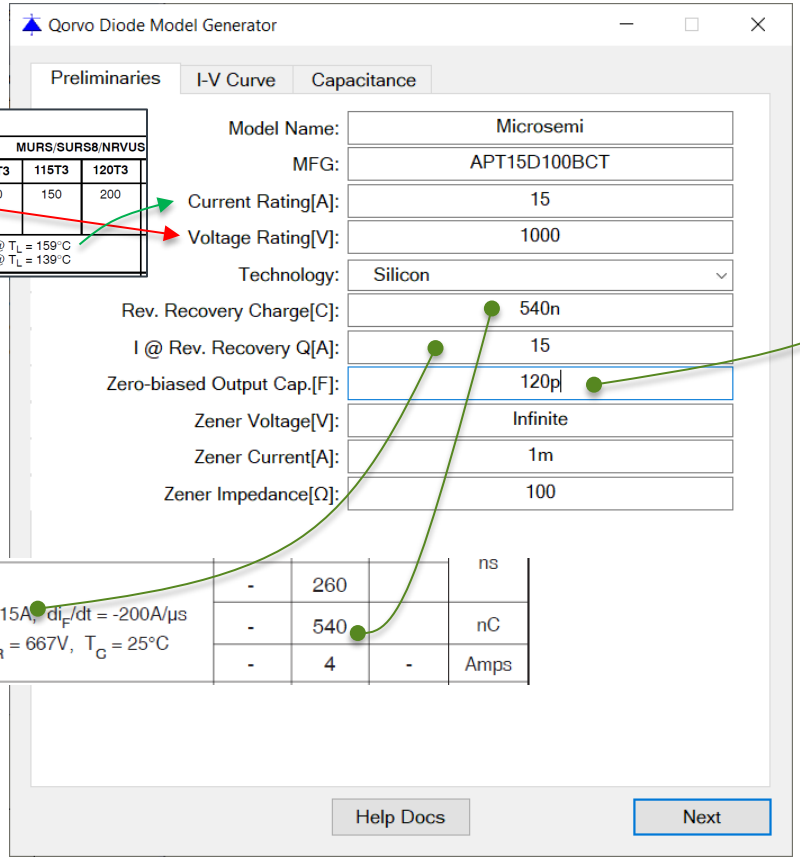


t_{rr}	Reverse Recovery Time	I_F = 15A, di_F/dt = -200A/µs V_R = 667V, T_G = 25°C	-	260		ns
Q_{rr}	Reverse Recovery Charge		-	540		nC
I_{RRM}	Maximum Reverse Recovery Current		-	4	-	Amps

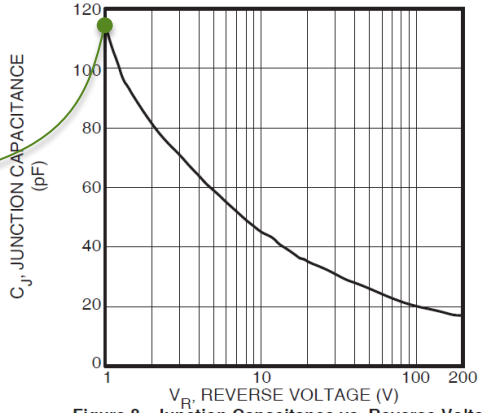


Figure 8. Junction Capacitance vs. Reverse Voltage

Example – Microchip APT15D100BCT Datasheet to Model Generator

Qspice reference is log plot (y-axis log, x-axis linear),
marker 1-5 is different if linear plot is used

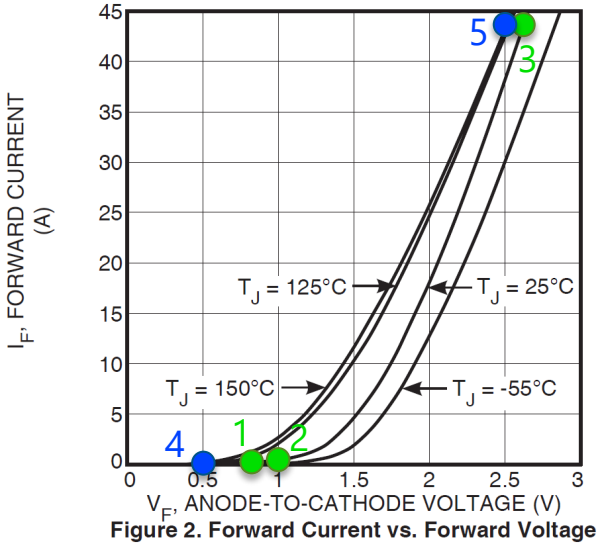
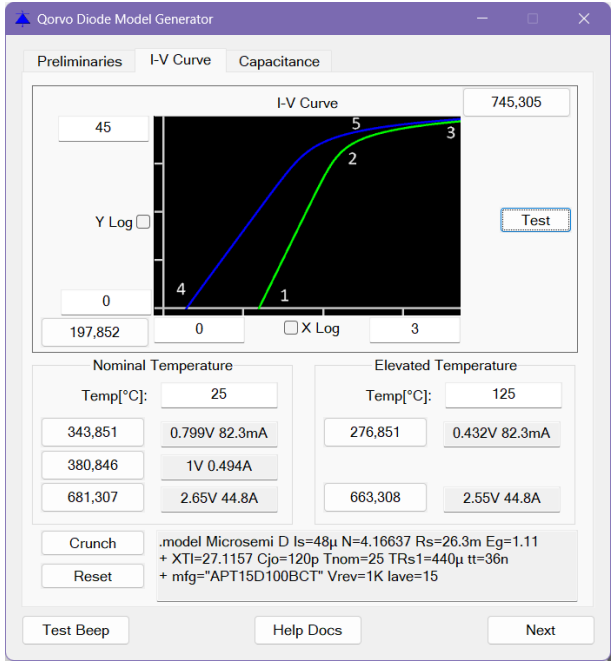
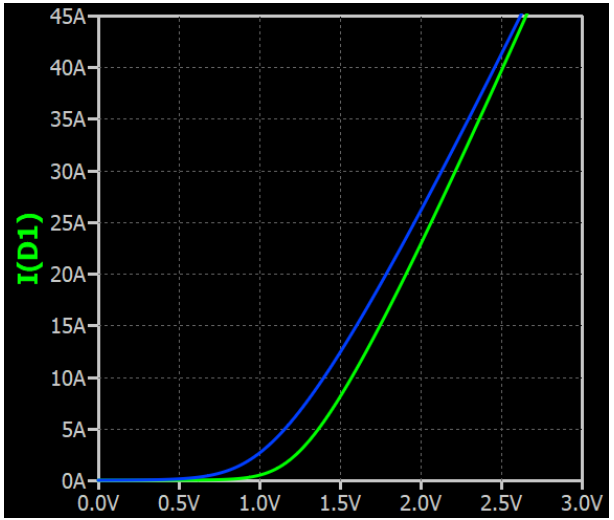


Figure 2. Forward Current vs. Forward Voltage





Marker 1 to 5 if linear plot is used
(y-axis and x-axis are both linear)

Example – Microchip APT15D100BCT Datasheet to Model Generator

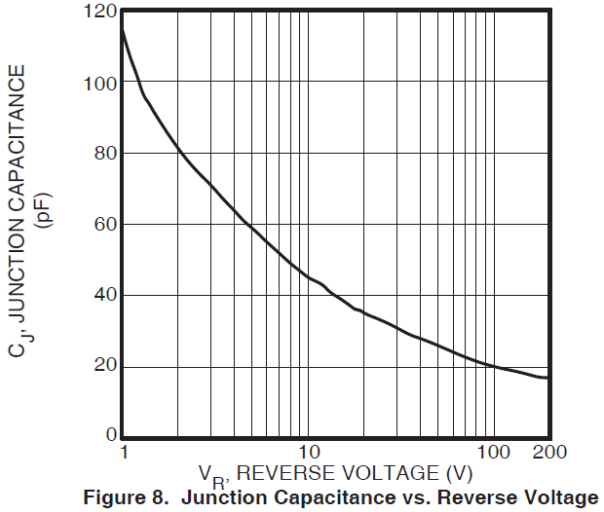
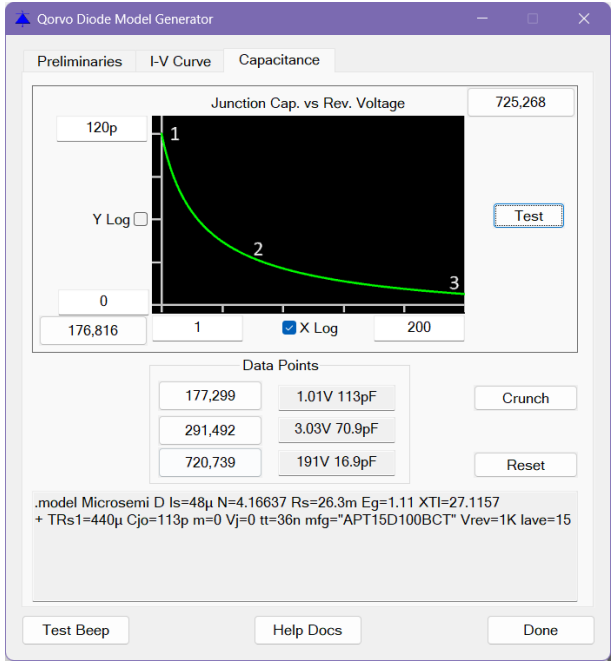
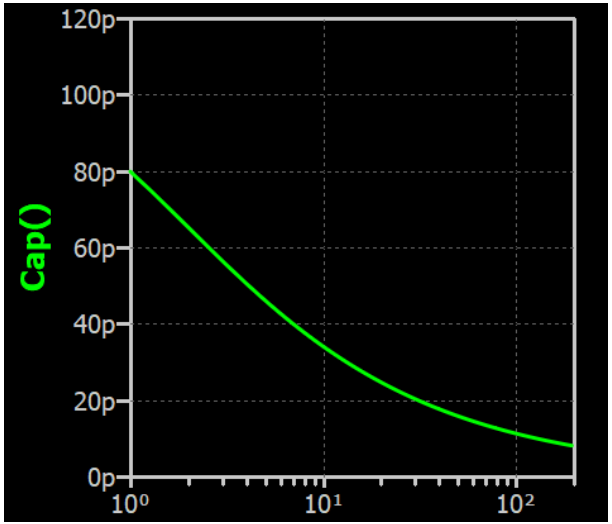


Figure 8. Junction Capacitance vs. Reverse Voltage





MOSFET Model Generator

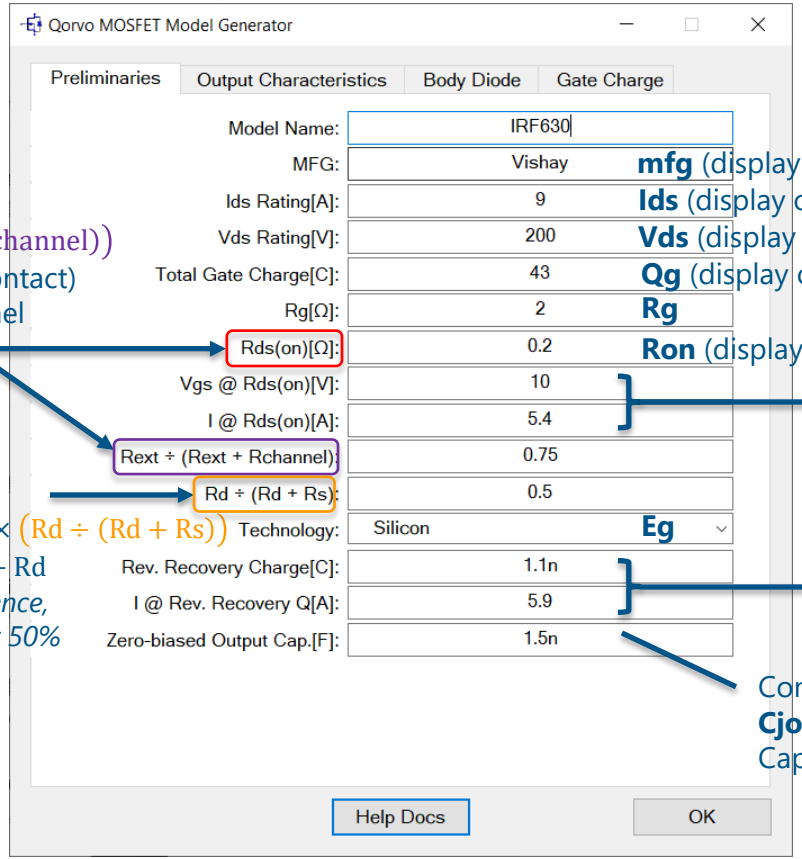
MOSFET.exe

MOSFET Model Generator

Parameters Generation

MOSFET Model Generator – Preliminaries Tab

Determine : mfg, Ids, Vds, Qg, Rg, Rds, Rd, Rs, Eg, tt



$Rd+Rs = Rds(on) \times \left(Rext \div (Rext + Rchannel)\right)$

- Rext = Rd + Rs (e.g. bond wire, contact)
- Rchannel is Rds of MOSFET channel

Not provide by datasheet, from Mike Engelhardt experience, in ~75% of resistance is contributed by Rext

$Rd = Rds(on) \times \left(Rext \div (Rext + Rchannel)\right) \times \left(Rd \div (Rd + Rs)\right)$

$Rs = Rds(on) \times \left(Rext \div (Rext + Rchannel)\right) - Rd$

Not provided by datasheet, from Mike experience, Ratio of Rd and Rs from Rext, approximate by 50%

Representation:

$$\frac{x}{x+y} \rightarrow 1 : x \gg y$$

$$\frac{x}{x+y} \rightarrow 0 : y \gg x$$

mfg (display only)

Ids (display only)

Vds (display only)

Qg (display only)

Rg

Ron (display), but also use to calculate **Rd** and **Rs**

Contribute to Calculation of **RonX** (formula unknown)

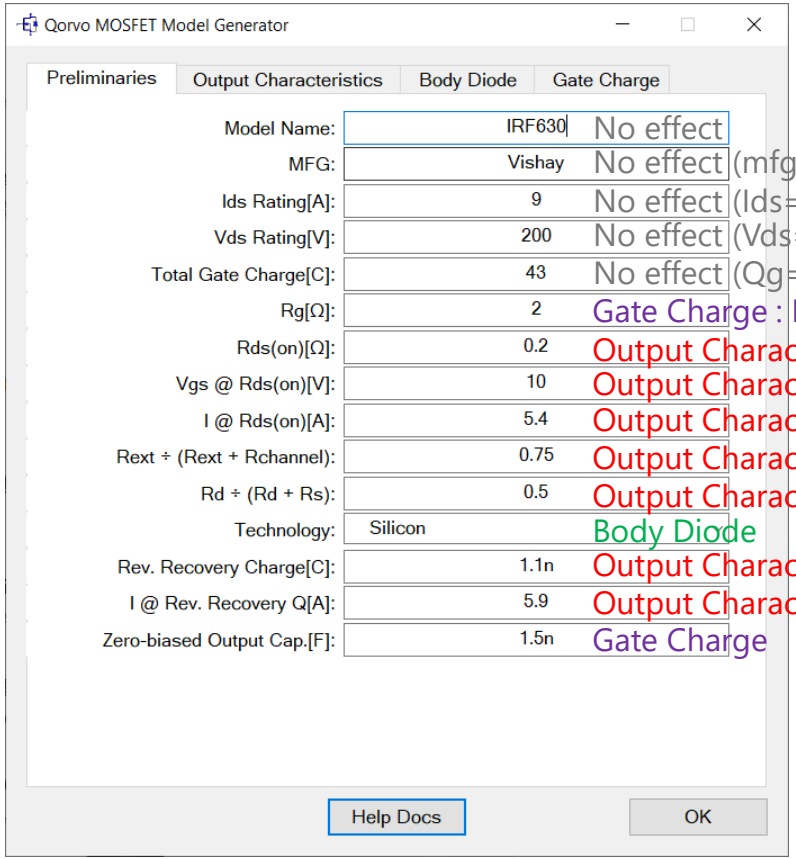
Eg

$$\textbf{tt} = \frac{\text{Rev Recovery Charge}}{\text{I @ Rev Recovery}}$$

Contribute to Calculation of **Cjo**

Cjo + Cgdmax = Zero-biased Output Cap

Capacitance @ 0Vds!



No effect

No effect (mfg=<str> display only)

No effect (Ids=<value> display only)

No effect (Vds=<value> display only)

No effect (Qg=<value> display only)

Gate Charge : Rg=<value>

Output Characteristics

Output Characteristics

Output Characteristics

Output Characteristics

Output Characteristics

Body Diode

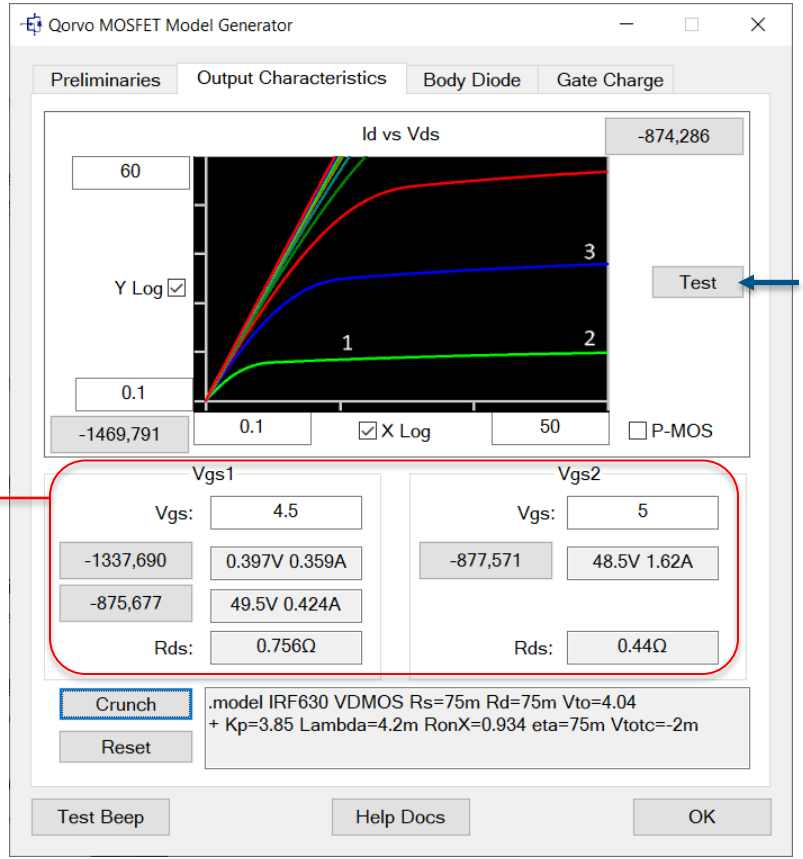
Output Characteristics : tt=<value>

Output Characteristics : tt=<value>

Gate Charge

MOSFET Model Generator – Output Characteristics

Determine : Vto, Kp, Lambda, RonX, eta, Vtotc



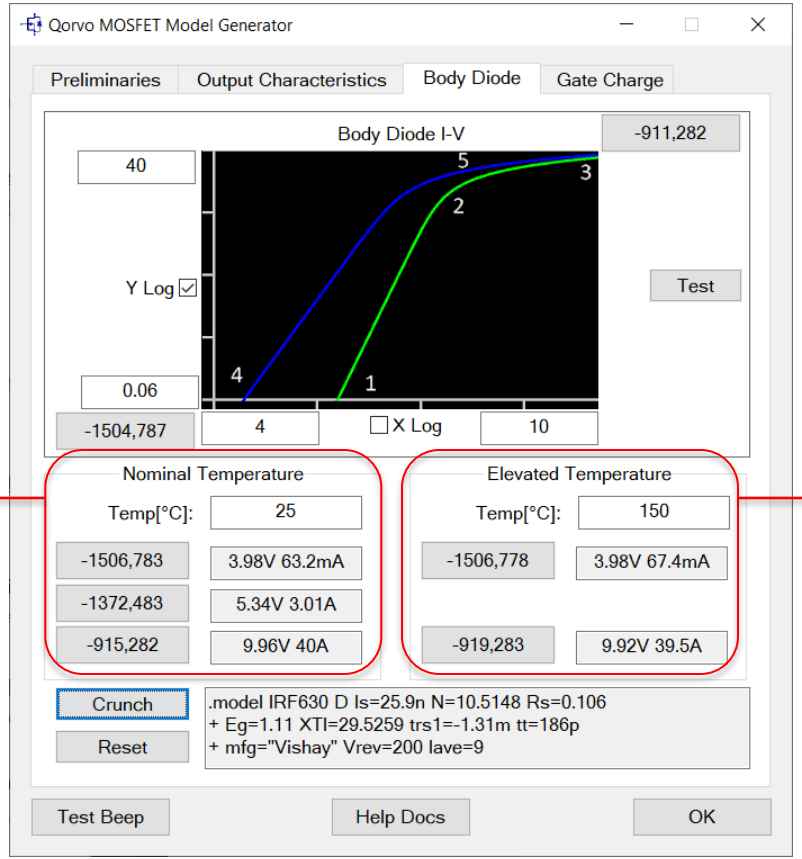
Determine **Vto**, **Kp, Lambda, RonX**

** **Rds,on** in preliminaries tab can be used to fine tuning Id vs Vds curve at lower Vds region

** **ETA** and **Vtotc** seems to be fixed
ETA=75m
Vtotc=-2m

MOSFET Model Generator – Body Diode

Determine : Is, N, Rs (Rb in MOS), TRs1, XTI



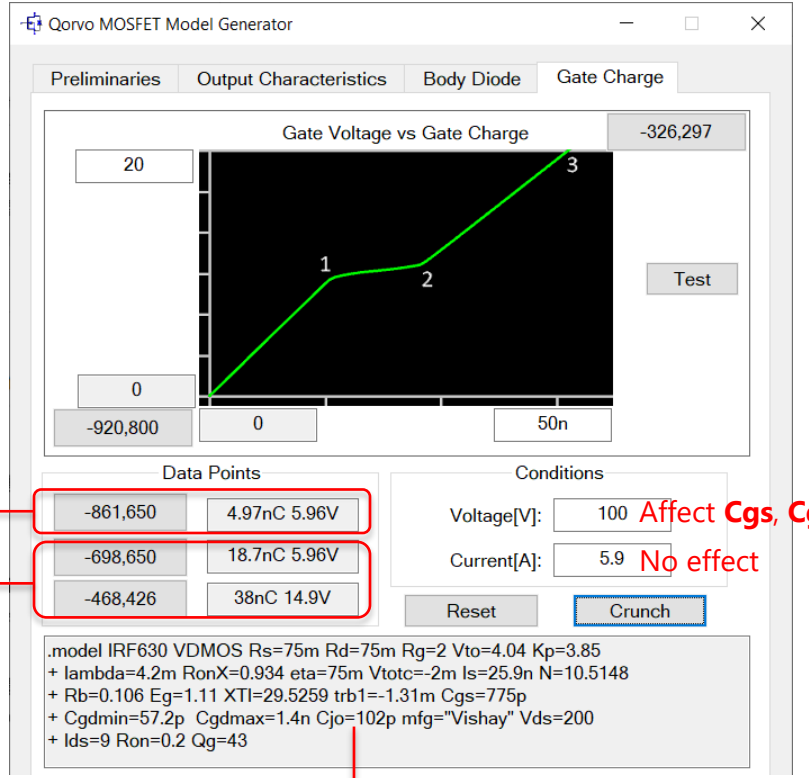
Determine **Is**, **N**, **Rs**

Determine **TRs1, XTI**
If Temp set to be identical nominal temperature, force TRs1=0 and XTI=3

** tt and Eg is from Perliminary tab
** Rs is series resistor in diode model, this will rename to Rb in VDMOS model in Gate Charge tab **(Rs → rename to Rb)**

MOSFET Model Generator – Gate Charge

Determine : Cgs, Cgdmin, Cgdmax, Cjo



mainly determine : **Cgs**

mainly determine : **Cgdmin**, **Cgdmax**

Affect **Cgs**, **Cgdmin, Cgdmax**, **Cjo**

No effect

Cjo=Zero-biased Output Cap (Preliminaries) – Cgdmax (min. value as 0)
[Cjo is body diode zero-bias capacitance]

MOSFET Model Generator

Example – Datasheet of Vishay IRF630

Example – Vishay IRF630 Datasheet to Model Generator

Gate input resistance	R_g	f = 1 MHz, open drain	0.6	-	3.3	Ω

Total gate charge	Q_g	V_{GS} = 10 V	I_D = 5.9 A, V_{DS} = 160 V, see fig. 6 and 13 [b]	-	-	43	nC
Gate-source charge	Q_{gs}			-	-	7.0	
Gate-drain charge	Q_{gd}			-	-	23	

Drain-source on-state resistance	$R_{DS(on)}$	V_{GS} = 10 V	I_D = 5.4 A [b]	-	-	0.40	Ω

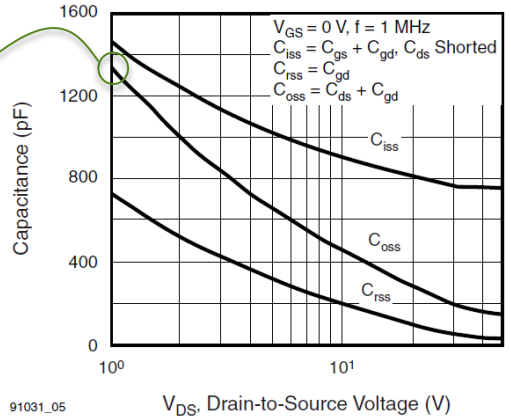
Body diode reverse recovery time	t_{rr}	T_J = 25 °C, I_F = 5.9 A, dI/dt = 100 A/µs	-	170	340	ns
Body diode reverse recovery charge	Q_{rr}		-	1.1	2.2	nC

Preliminaries | Output Characteristics | Body Diode | Gate Charge

Model Name:	IRF630
MFG:	Vishay
Ids Rating[A]:	9
Vds Rating[V]:	200
Total Gate Charge[C]:	43n
Rg[Ω]:	2
Rds(on)[Ω]:	0.4
Vgs @ Rds(on)[V]:	10
I @ Rds(on)[A]:	5.4
Rext / (Rext + Rchannel):	0.75
Rd / (Rd + Rs):	0.0
Technology:	Silicon
Rev. Recovery Charge[C]:	1.1
I @ Rev. Recovery Q[A]:	5.9
Zero-biased Output Cap.[F]:	1300p

Help Docs | Next

Coss at 0Vdc



Example – Vishay IRF630 Datasheet to Model Generator

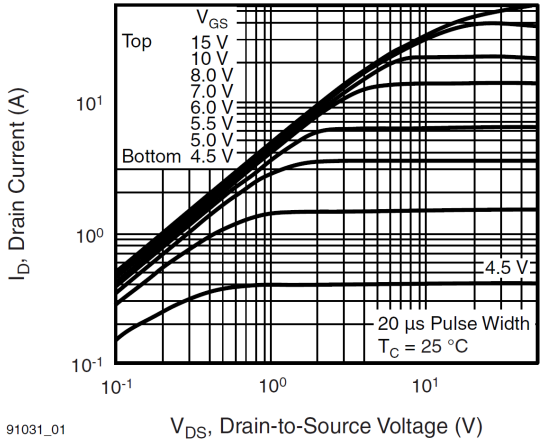
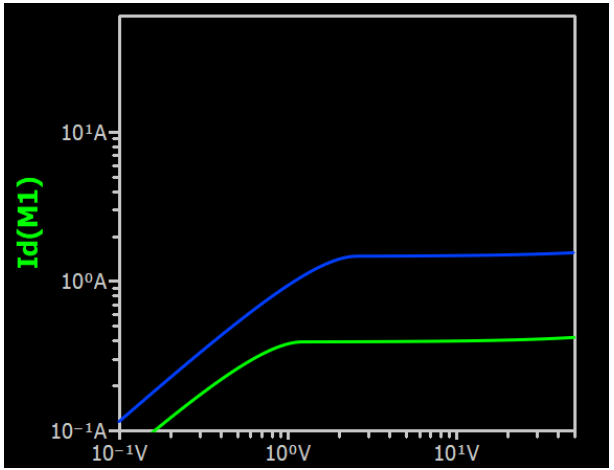


Fig. 1 - Typical Output Characteristics, T_C = 25 °C



Example – Vishay IRF630 Datasheet to Model Generator

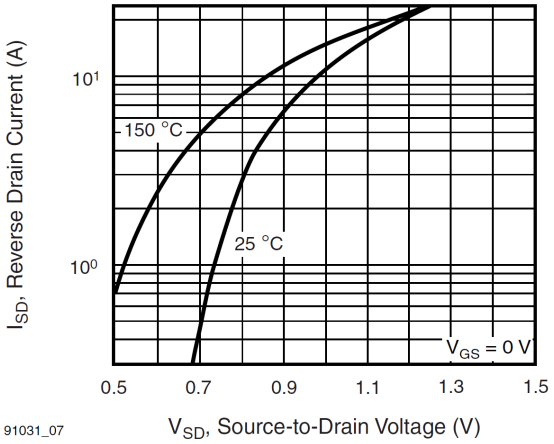
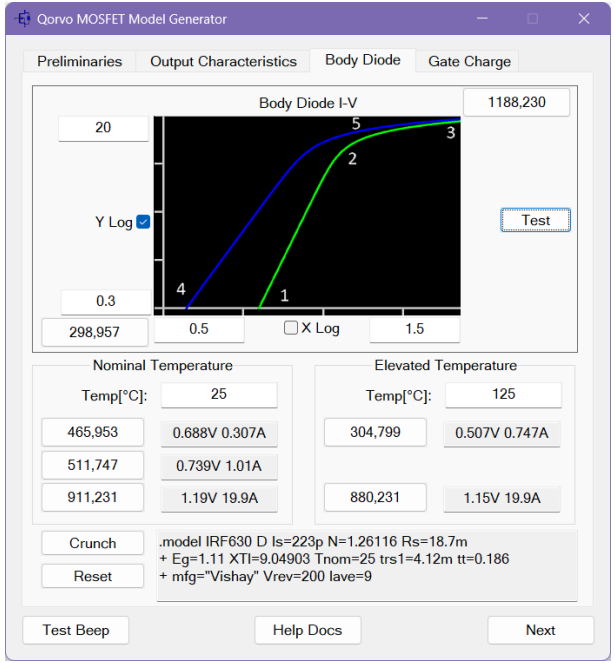
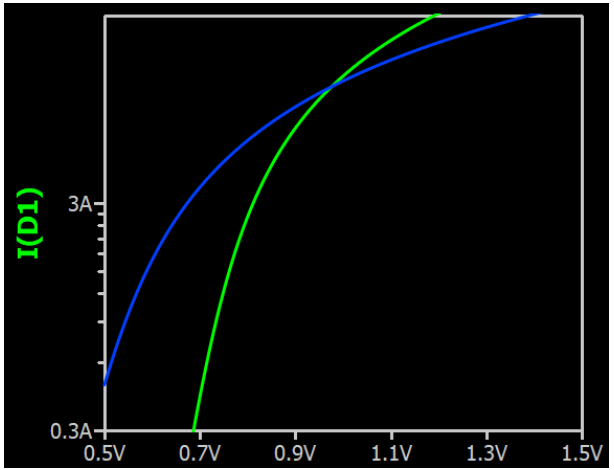


Fig. 7 - Typical Source-Drain Diode Forward Voltage





Example – Vishay IRF630 Datasheet to Model Generator

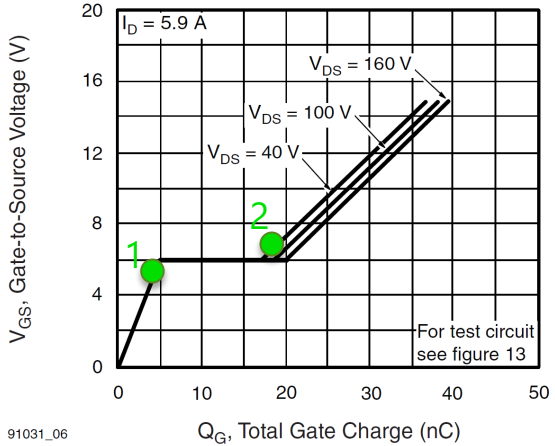
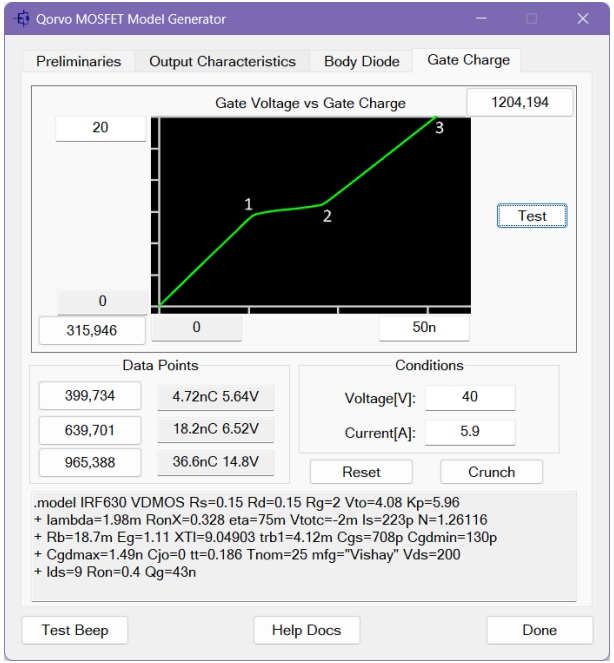
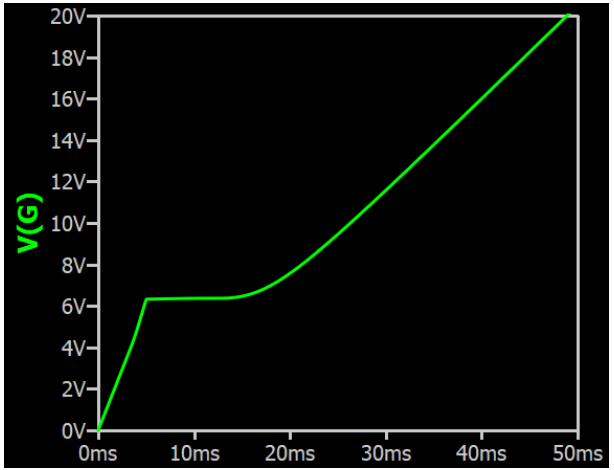


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

According to Mike, Point #1 and #2 are sampled slightly lower and slightly higher than flat region

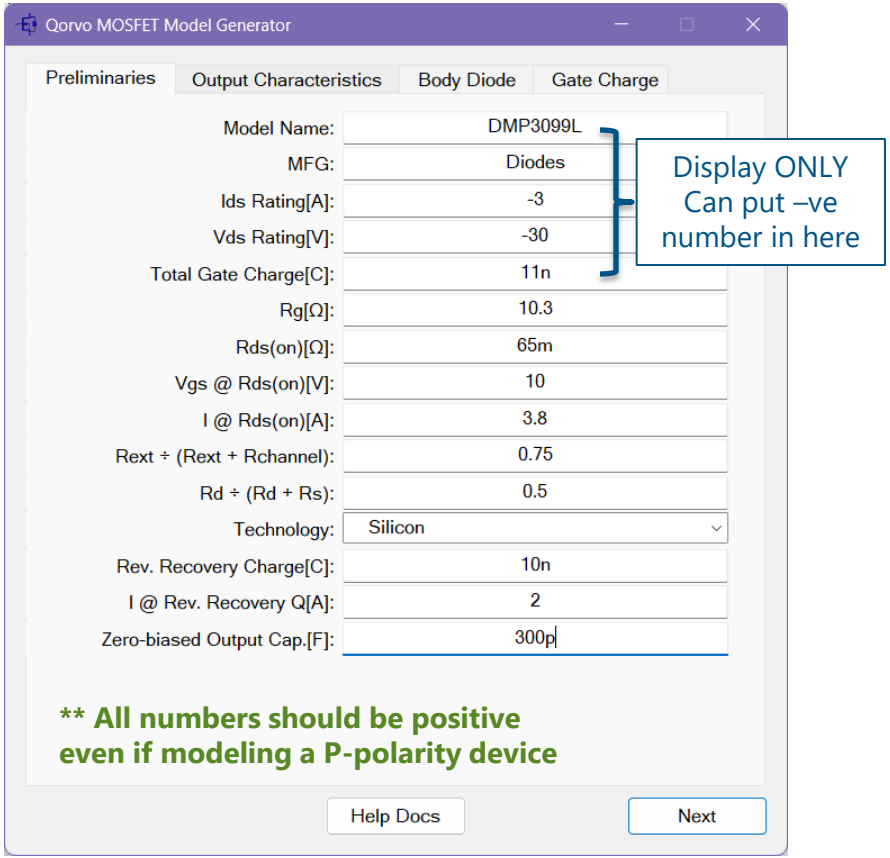




MOSFET Model Generator

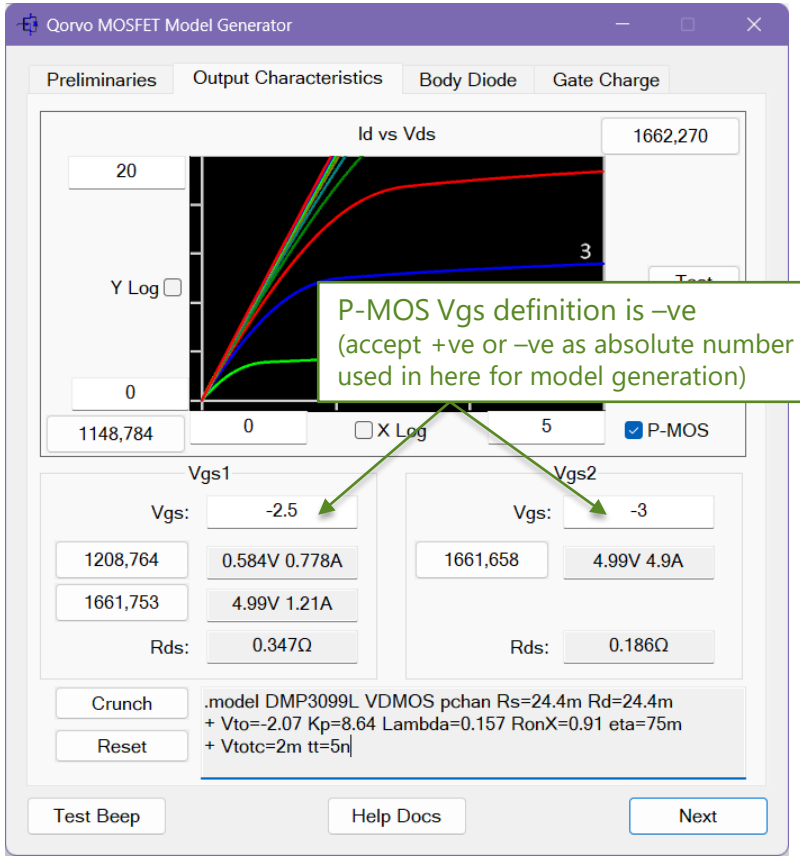
Example – pMOS DMP3099L

pMOS DMP3099L – Preliminaries and Output Characteristics



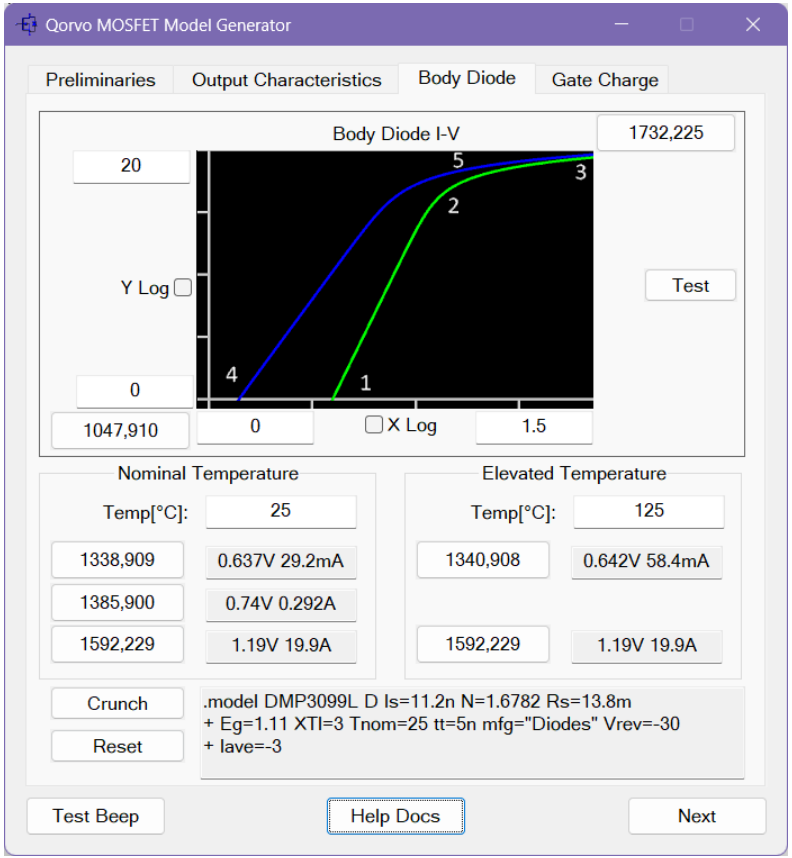
Display ONLY
Can put –ve number in here

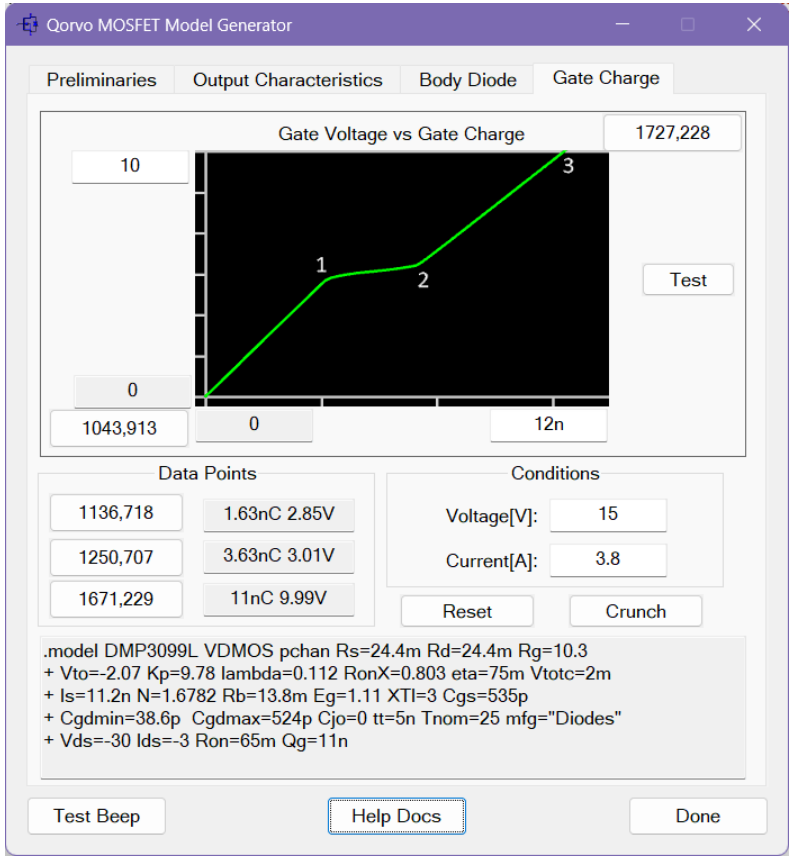
**** All numbers should be positive even if modeling a P-polarity device**



P-MOS Vgs definition is –ve
(accept +ve or –ve as absolute number is used in here for model generation)

pMOS DMP3099L – Body Diode and Gate Charge



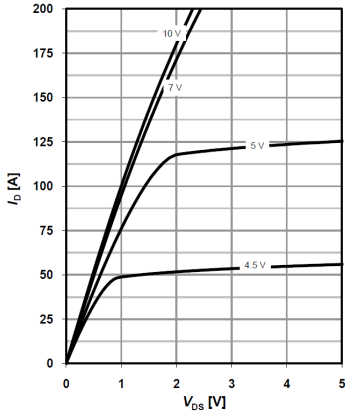


MOSFET Model Generator

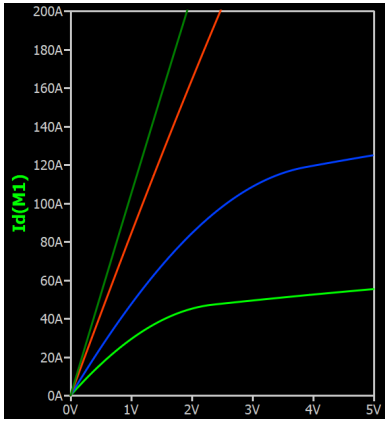
Effect of Parameters in Preliminaries Sheet

Effect of Rext ÷ Rext + Rchannel

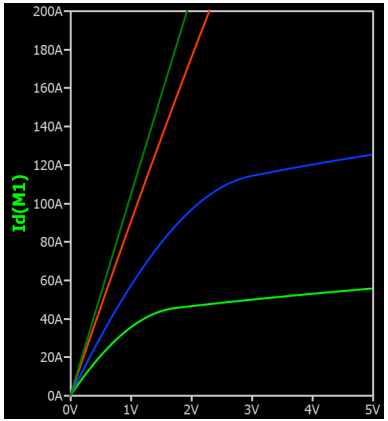
- Rext ÷ Rext + Rchannel
  - Infineon IPB107N20N3G as example
  - Value = 0.75
    - .model IPB107N20N3G VDMOS Rs=3.6m Rd=3.6m Vto=3.84 Kp=294 Lambda=0.167 RonX=0.243
  - Value = 0.85
    - .model IPB107N20N3G VDMOS Rs=4.08m Rd=4.08m Vto=3.88 Kp=379 Lambda=0.197 RonX=0.318
  - Value = 0.95
    - .model IPB107N20N3G VDMOS Rs=4.56m Rd=4.56m Vto=3.92 Kp=505 Lambda=0.241 RonX=0.727
  - Adjusting the ratio of external and channel resistance affects the width ohmic region



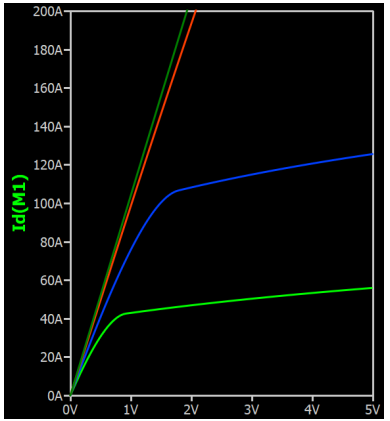
Rext ÷ Rext + Rchannel = 0.75 (default)



Rext ÷ Rext + Rchannel = 0.85 (default)



Rext ÷ Rext + Rchannel = 0.95 (default)

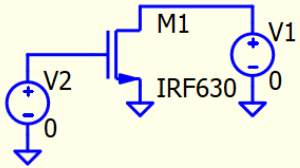


MOSFET Model Generator

Effect of Model Parameters

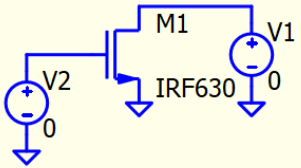
#1 : Output Characteristic – Rs, Rd

Qspice : Sensitivity Study - Output Characteristic.qsch



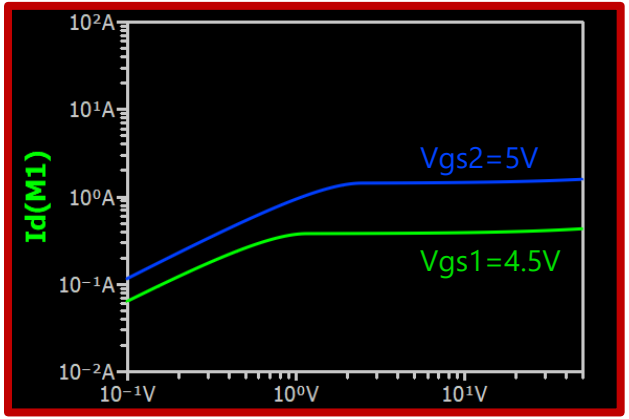
Rs

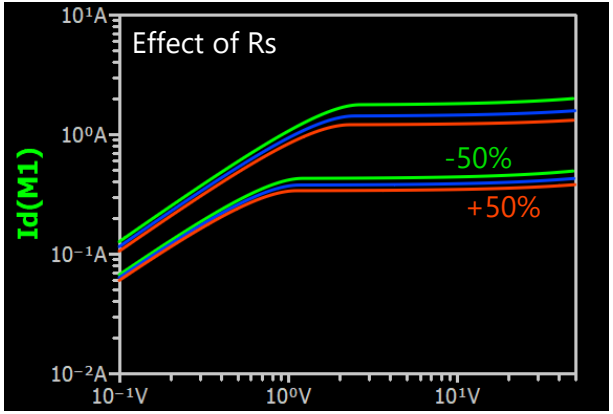
```
.dc V1 0.1 50 1m V2 list 4.5 5
.model IRF630 VDMOS Rs=0.15*chg Rd=0.15
+ Vto=4.08 Kp=5.63 Lambda=3.85m
+ RonX=0.348 eta=75m Vtotc=-2m tt=0.186

;multiple chg (*chg)
.step param chg list 0.5 1 1.5
```

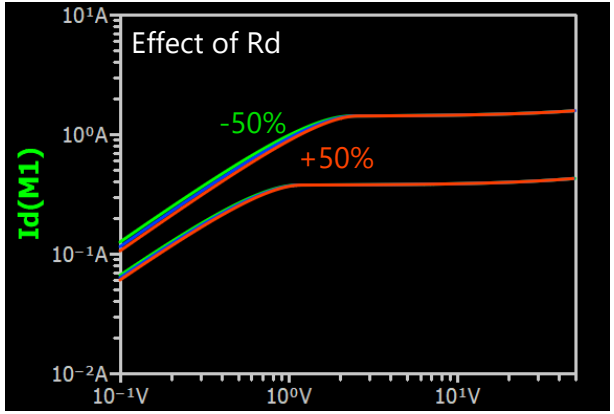


Rd

```
.dc V1 0.1 50 1m V2 list 4.5 5
.model IRF630 VDMOS Rs=0.15 Rd=0.15*chg
+ Vto=4.08 Kp=5.63 Lambda=3.85m
+ RonX=0.348 eta=75m Vtotc=-2m tt=0.186

;multiple chg (*chg)
.step param chg list 0.5 1 1.5
```



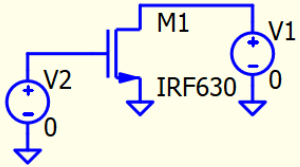




#1 : Output Characteristic – Vto, Kp, Lambda

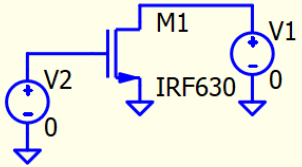
Qspice : Sensitivity Study - Output Characteristic.qsch

Vto



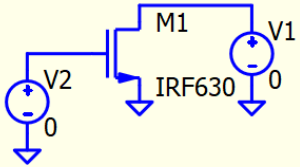

```
.dc V1 0.1 50 1m V2 list 4.5 5
.model IRF630 VDMOS Rs=0.15 Rd=0.15
+ Vto=4.08*chg Kp=5.63 Lambda=3.85m
+ RonX=0.348 eta=75m Vtotc=-2m tt=0.186

;multiple chg (*chg)
.step param chg list 0.98 1 1.02
```

Kp

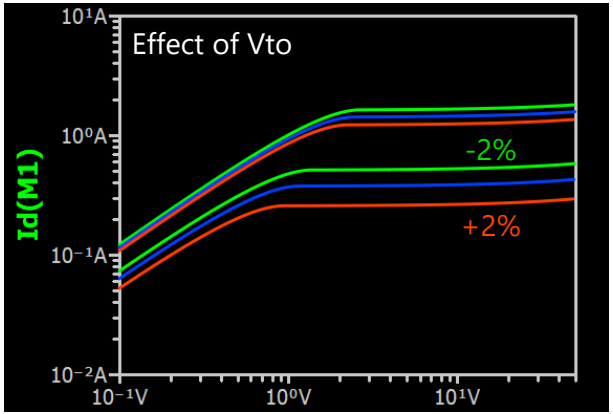


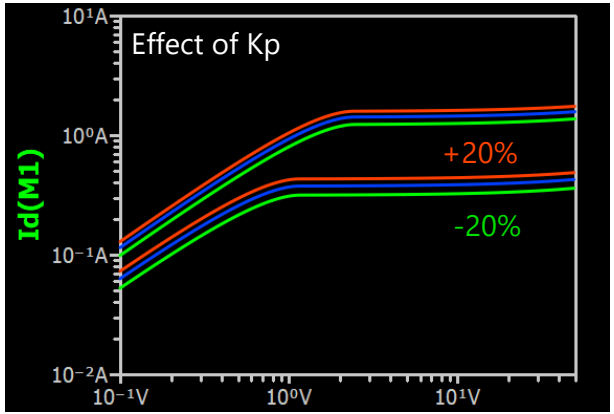

```
.dc V1 0.1 50 1m V2 list 4.5 5
.model IRF630 VDMOS Rs=0.15 Rd=0.15
+ Vto=4.08 Kp=5.63*chg Lambda=3.85m
+ RonX=0.348 eta=75m Vtotc=-2m tt=0.186

;multiple chg (*chg)
.step param chg list 0.8 1 1.2
```

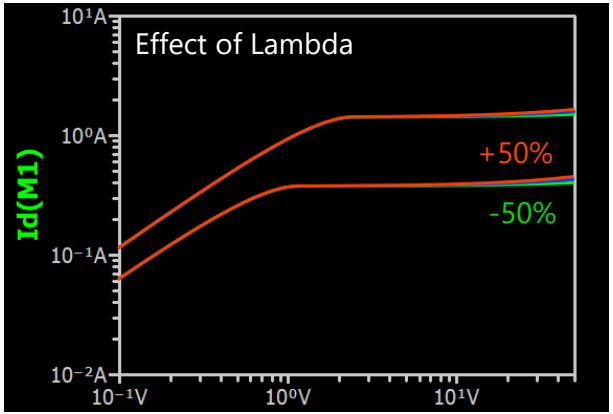
Lambda




```
.dc V1 0.1 50 1m V2 list 4.5 5
.model IRF630 VDMOS Rs=0.15 Rd=0.15
+ Vto=4.08 Kp=5.63 Lambda=3.85m*chg
+ RonX=0.348 eta=75m Vtotc=-2m tt=0.186

;multiple chg (*chg)
.step param chg list 0.5 1 1.5
```

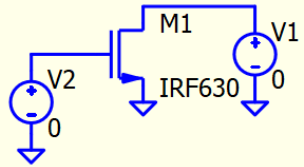






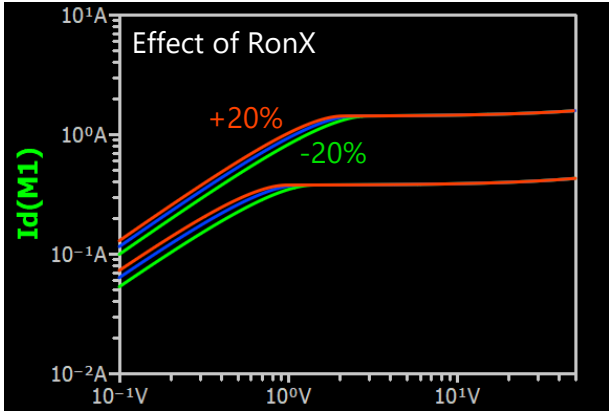
#1 : Output Characteristic – RonX

Qspice : Sensitivity Study - Output Characteristic.qsch



RonX

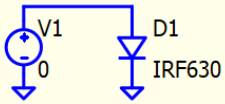
```
.dc V1 0.1 50 1m V2 list 4.5 5
.model IRF630 VDMOS Rs=0.15 Rd=0.15
+ Vto=4.08 Kp=5.63 Lambda=3.85m
+ RonX=0.348*chg eta=75m Vtotc=-2m tt=0.186

;multiple chg (*chg)
.step param chg list 0.8 1 1.2
```



#2 : Bode Diode – XTI, trs1 (Temperature Effect)

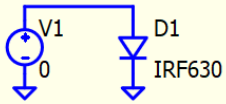
Qspice : Sensitivity Study - Body Diode.qsch

XTI

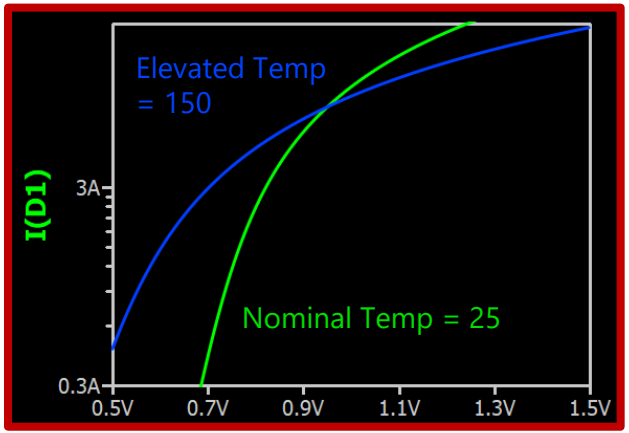


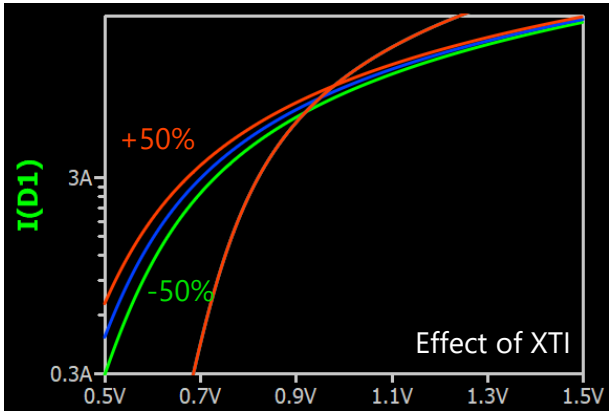

```
.dc V1 0.5 1.5 1m
;.temp 25 150
.model IRF630 D Is=785p N=1.33849 Rs=21m Eg=1.11
+ XTI=4.53261*chg Tnom=25 trs1=3.56m tt=0.186
+ mfg="Vishay" Vrev=200 Iave=9

;multiple chg (*chg)
.step param temp list 25 150 param chg list 0.5 1 1.5
```

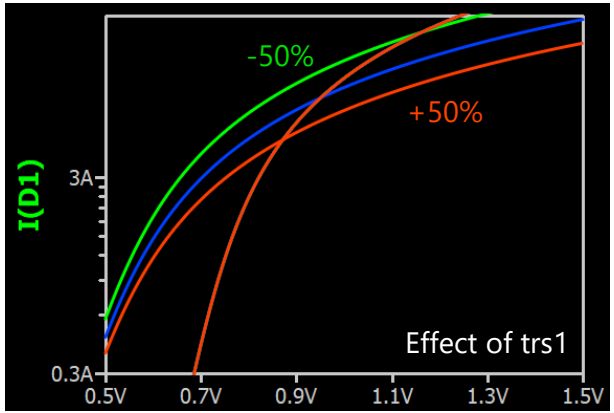
trs1




```
.dc V1 0.5 1.5 1m
;.temp 25 150
.model IRF630 D Is=785p N=1.33849 Rs=21m Eg=1.11
+ XTI=4.53261 Tnom=25 trs1=3.56m*chg tt=0.186
+ mfg="Vishay" Vrev=200 Iave=9

;multiple chg (*chg)
.step param temp list 25 150 param chg list 0.5 1 1.5
```



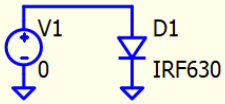




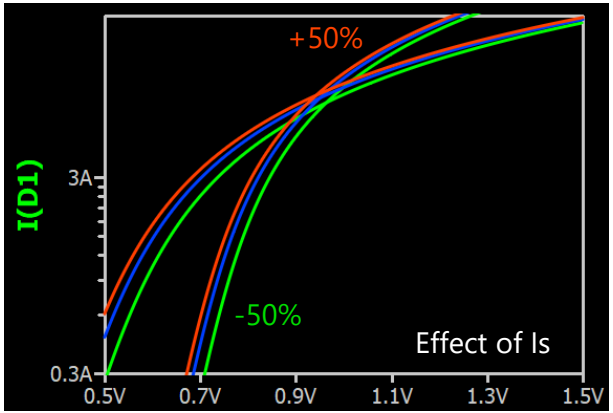
#2 : Bode Diode – Is, N, Rs (Rb in MOS)

Qspice : Sensitivity Study - Body Diode.qsch

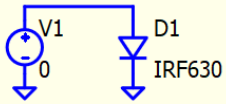
Is



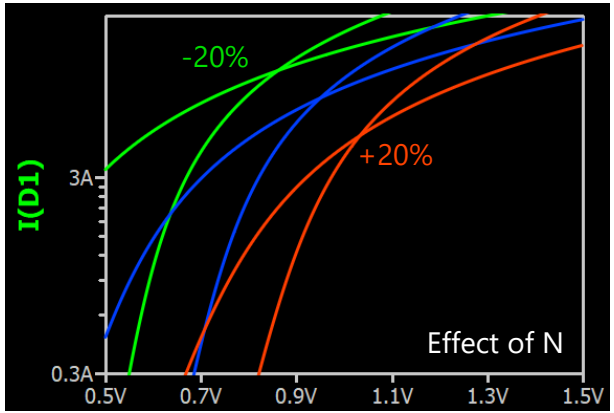

```
.dc V1 0.5 1.5 1m
;.temp 25 150
.model IRF630 D Is=785p*chg N=1.33849 Rs=21m Eg=1.11
+ XTI=4.53261 Tnom=25 trs1=3.56m tt=0.186
+ mfg="Vishay" Vrev=200 Iave=9

;multiple chg (*chg)
.step param temp list 25 150 param chg list 0.5 1 1.5
```



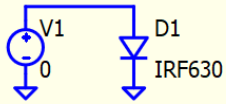
N



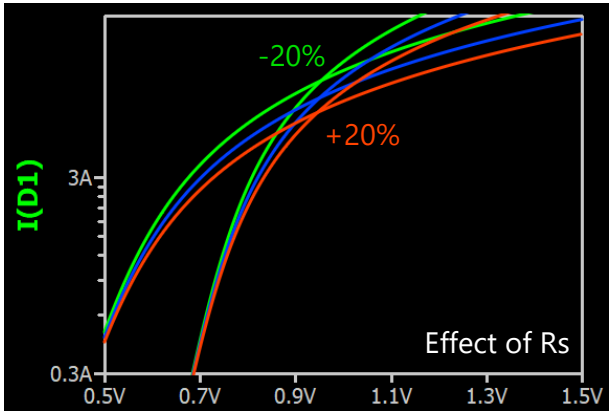

```
.dc V1 0.5 1.5 1m
;.temp 25 150
.model IRF630 D Is=785p N=1.33849*chg Rs=21m Eg=1.11
+ XTI=4.53261 Tnom=25 trs1=3.56m tt=0.186
+ mfg="Vishay" Vrev=200 Iave=9

;multiple chg (*chg)
.step param temp list 25 150 param chg list 0.8 1 1.2
```



Rs (Rb in MOS)



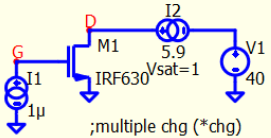

```
.dc V1 0.5 1.5 1m
;.temp 25 150
.model IRF630 D Is=785p N=1.33849 Rs=21m*chg Eg=1.11
+ XTI=4.53261 Tnom=25 trs1=3.56m tt=0.186
+ mfg="Vishay" Vrev=200 Iave=9

;multiple chg (*chg)
.step param temp list 25 150 param chg list 0.8 1 1.2
```



#3 : Gate Charge – Cgs, Cgdmin, Cgdmax

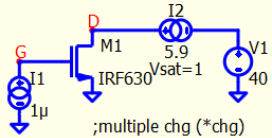
Qspice : Sensitivity Study - Gate Charge.qsch

Ggs



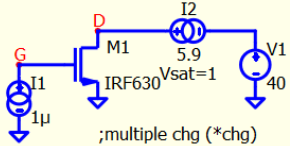

```
;multiple chg (*chg)
.step param chg list 0.5 1 1.5
.tran 0.05
.ic V(G)=0
.model IRF630 VDMOS Rs=0.15 Rd=0.15 Rg=2 Vto=4.08 Kp=5.63
+ lambda=3.85m RonX=0.348 eta=75m Vtotc=-2m Is=785p N=1.33849
+ Rb=21m Eg=1.11 XTI=4.53261 trb1=3.56m Cgs=668p*chg Cgdmin=133p
+ Cgdmax=1.57n Cjo=0 tt=0.186 Tnom=25 mfg="Vishay" Vds=200
+ Ids=9 Ron=0.4 Qg=43n
```

Ggdmin

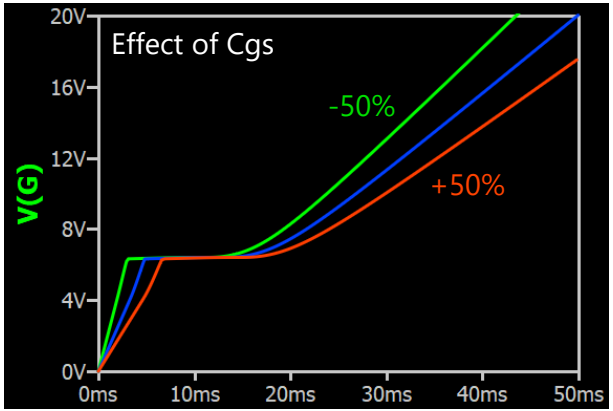


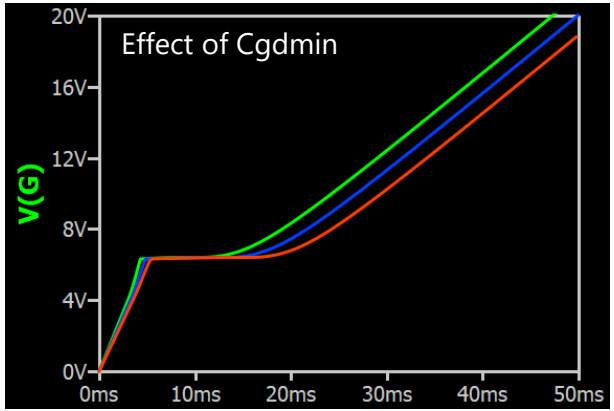

```
;multiple chg (*chg)
.step param chg list 0.5 1 1.5
.tran 0.05
.ic V(G)=0
.model IRF630 VDMOS Rs=0.15 Rd=0.15 Rg=2 Vto=4.08 Kp=5.63
+ lambda=3.85m RonX=0.348 eta=75m Vtotc=-2m Is=785p N=1.33849
+ Rb=21m Eg=1.11 XTI=4.53261 trb1=3.56m Cgs=668p Cgdmin=133p*chg
+ Cgdmax=1.57n Cjo=0 tt=0.186 Tnom=25 mfg="Vishay" Vds=200
+ Ids=9 Ron=0.4 Qg=43n
```

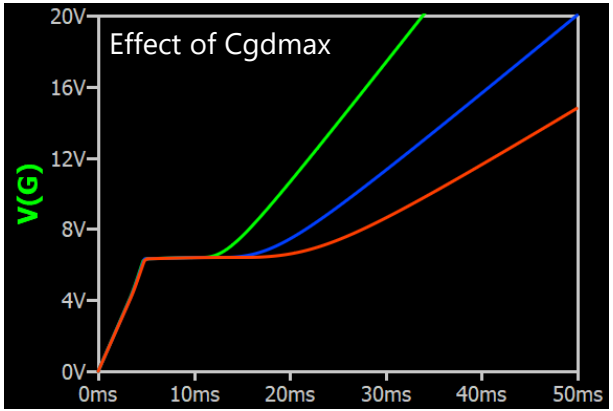
Ggdmax




```
;multiple chg (*chg)
.step param chg list 0.5 1 1.5
.tran 0.05
.ic V(G)=0
.model IRF630 VDMOS Rs=0.15 Rd=0.15 Rg=2 Vto=4.08 Kp=5.63
+ lambda=3.85m RonX=0.348 eta=75m Vtotc=-2m Is=785p N=1.33849
+ Rb=21m Eg=1.11 XTI=4.53261 trb1=3.56m Cgs=668p Cgdmin=133p
+ Cgdmax=1.57n*chg Cjo=0 tt=0.186 Tnom=25 mfg="Vishay" Vds=200
+ Ids=9 Ron=0.4 Qg=43n
```



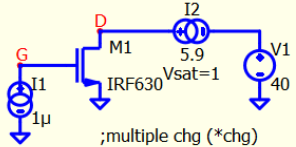




#3 : Gate Charge – Rs, Vto, Kp (from Output Characteristic Parameters)

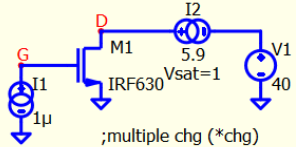
Qspice : Sensitivity Study - Gate Charge.qsch

Rs



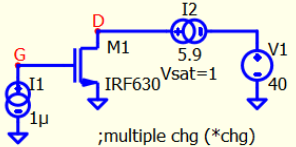

```
;multiple chg (*chg)
.step param chg list 0.5 1 1.5
.tran 0.05
.ic V(G)=0
.model IRF630 VDMOS Rs=0.15*chg Rd=0.15 Rg=2 Vto=4.08 Kp=5.63
+ lambda=3.85m RonX=0.348 eta=75m Vtotc=-2m Is=785p N=1.33849
+ Rb=21m Eg=1.11 XTI=4.53261 trb1=3.56m Cgs=668p Cgdmin=133p
+ Cgdmax=1.57n Cjo=0 tt=0.186 Tnom=25 mfg="Vishay" Vds=200
+ Ids=9 Ron=0.4 Qg=43n
```

Vto

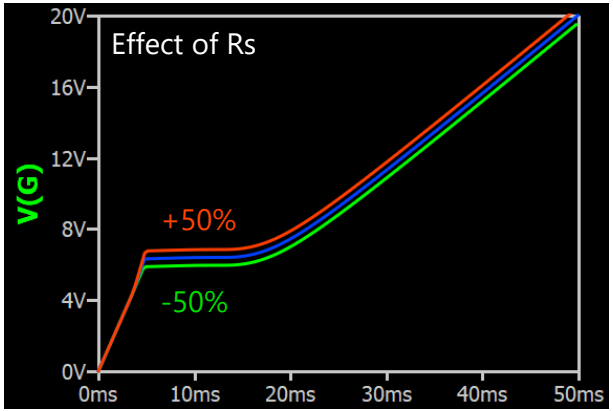


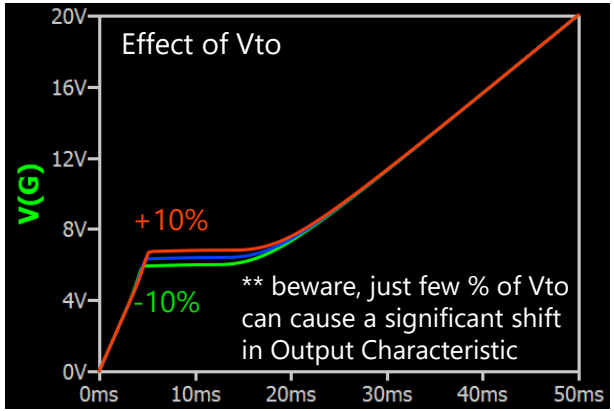

```
;multiple chg (*chg)
.step param chg list 0.9 1 1.1
.tran 0.05
.ic V(G)=0
.model IRF630 VDMOS Rs=0.15 Rd=0.15 Rg=2 Vto=4.08*chg Kp=5.63
+ lambda=3.85m RonX=0.348 eta=75m Vtotc=-2m Is=785p N=1.33849
+ Rb=21m Eg=1.11 XTI=4.53261 trb1=3.56m Cgs=668p Cgdmin=133p
+ Cgdmax=1.57n Cjo=0 tt=0.186 Tnom=25 mfg="Vishay" Vds=200
+ Ids=9 Ron=0.4 Qg=43n
```

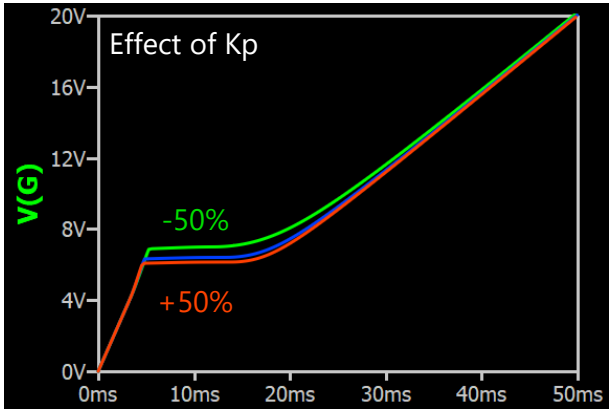
Kp




```
;multiple chg (*chg)
.step param chg list 0.5 1 1.5
.tran 0.05
.ic V(G)=0
.model IRF630 VDMOS Rs=0.15 Rd=0.15 Rg=2 Vto=4.08 Kp=5.63*chg
+ lambda=3.85m RonX=0.348 eta=75m Vtotc=-2m Is=785p N=1.33849
+ Rb=21m Eg=1.11 XTI=4.53261 trb1=3.56m Cgs=668p Cgdmin=133p
+ Cgdmax=1.57n Cjo=0 tt=0.186 Tnom=25 mfg="Vishay" Vds=200
+ Ids=9 Ron=0.4 Qg=43n
```



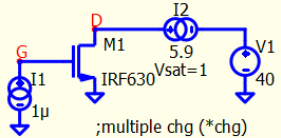




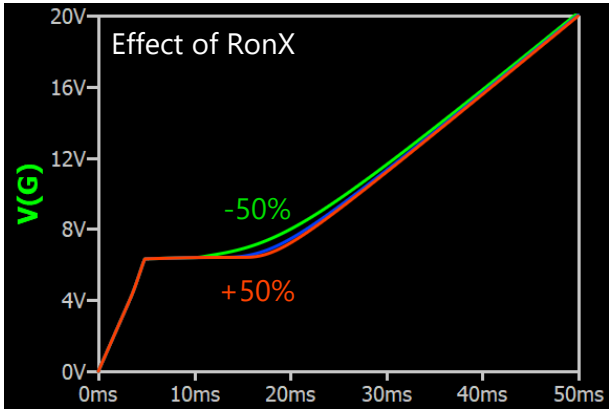
#3 : Gate Charge – Rs, Vto, Kp (from Output Characteristic Parameters)

Qspice : Sensitivity Study - Gate Charge.qsch

RonX

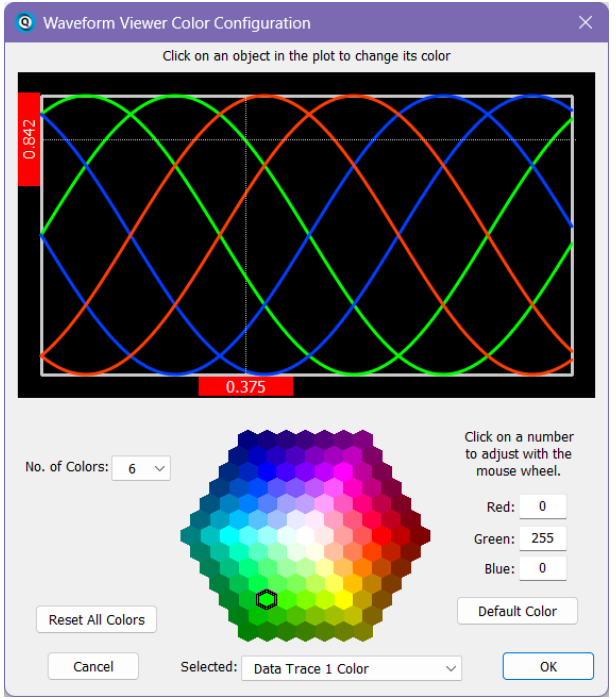



```
;multiple chg (*chg)
.step param chg list 0.5 1 1.5
.tran 0.05
.ic V(G)=0
.model IRF630 VDMOS Rs=0.15 Rd=0.15 Rg=2 Vto=4.08 Kp=5.63
+ lambda=3.85m RonX=0.348*chg eta=75m Vtotc=-2m Is=785p N=1.33849
+ Rb=21m Eg=1.11 Xti=4.53261 trb1=3.56m Cgs=668p Cgdmin=133p
+ Cgdmax=1.57n Cjo=0 tt=0.186 Tnom=25 mfg="Vishay" Vds=200
+ Ids=9 Ron=0.4 Qg=43n
```



Waveform Viewer Color Configuration for Sensitivity Study

- In sensitivity study, as triple sweep is used in Output Characteristic and Body Diode, color trace in waveform viewer is setup as
  - Data Trace 1 Color : [0,255,0]
  - Data Trace 2 Color : [0,255,0]
  - Data Trace 3 Color : [0,63,255]
  - Data Trace 4 Color : [0,63,255]
  - Data Trace 5 Color : [255,63,0]
  - Data Trace 6 Color : [255,63,0]



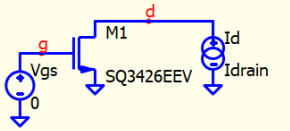
MOSFET Model Generator

Example – Recreate from a model

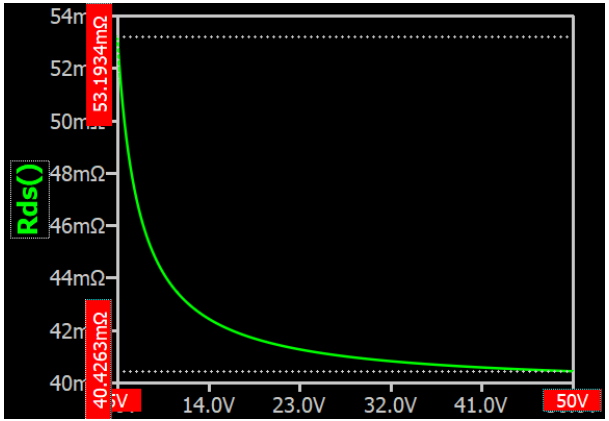
Determine Rds(on), Vgs, Idrain @ Rds(on) and Rext÷(Rext+Rchannel)

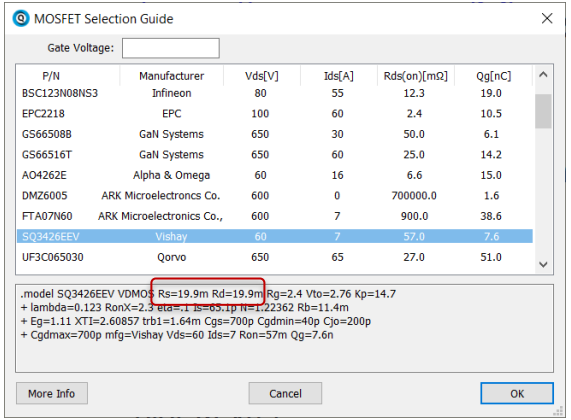
Qspice : Preliminaries (Rdson Vgs Idrain and Rext).qsch

- Rext : Rd + Rs
  - Rds(on) is basically consist of Rext (external resistance : Rd, Rs) and Rchannel (channel resistance)
  - To estimate Rext, fully turn ON a FET model with extreme gate-source voltage, which minimized Rchannel and Rds(on) is dominated by Rext
  - In this example, Rs+Rd=Rext=39.8mΩ. And by extreme gate-source, Rext=40.6mΩ




```
; force Rext >> Rchannel with extreme Vgs
;   therefore, Rext = Rd + Rs
.param Idrain=1

.dc Vgs 5 50 .1 ; sweep to unrealistically high for Rext
.func Rds() V(d)/I(Id)
.plot Rds()

.meas Rdson max Rds()
.meas Ids@Rdson min I(Id)
.meas Vgs@Rdson min V(g)
.meas Rext min Rds()
.meas Reqn Rext/(Rext+(Rdson-Rext))
```





- Now put,
  - Rds(on) = 53.2mΩ
  - Vgs @ Rds(on) = 5V
  - Idrain @ Rds(on) = 1A
  - Rext = Rs+Rd = 40.6mΩ
  - Rchannel@Rds(on)
    = Rds(on) – Rext
    = 53.2mΩ – 40.6mΩ
    = 12.6mΩ
  - Rext÷(Rext+Rchannel)
    = 40.6Ω /(40.6Ω +12.6Ω)
    =0.763Ω

Determine Rg from a MOSFET Model

Qspice : Preliminaries - Rg.qsch

- Rg
  - Rg is series resistance in gate
  - Rg can be identified with ac analysis and only read the real part with Cartesian representation
  - Now, put
    - Rg = value of Zr()