Qspice - Model Generators Guide by KSKelvin

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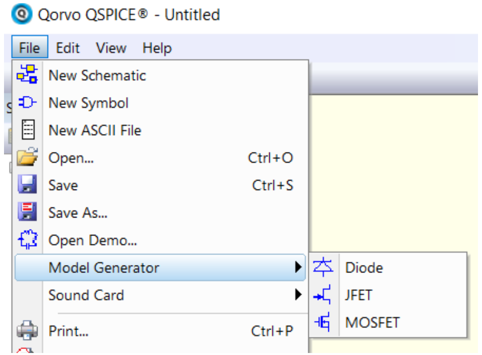
Model Generator and Precaution in using this Guide

- 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

Diode Model Generator

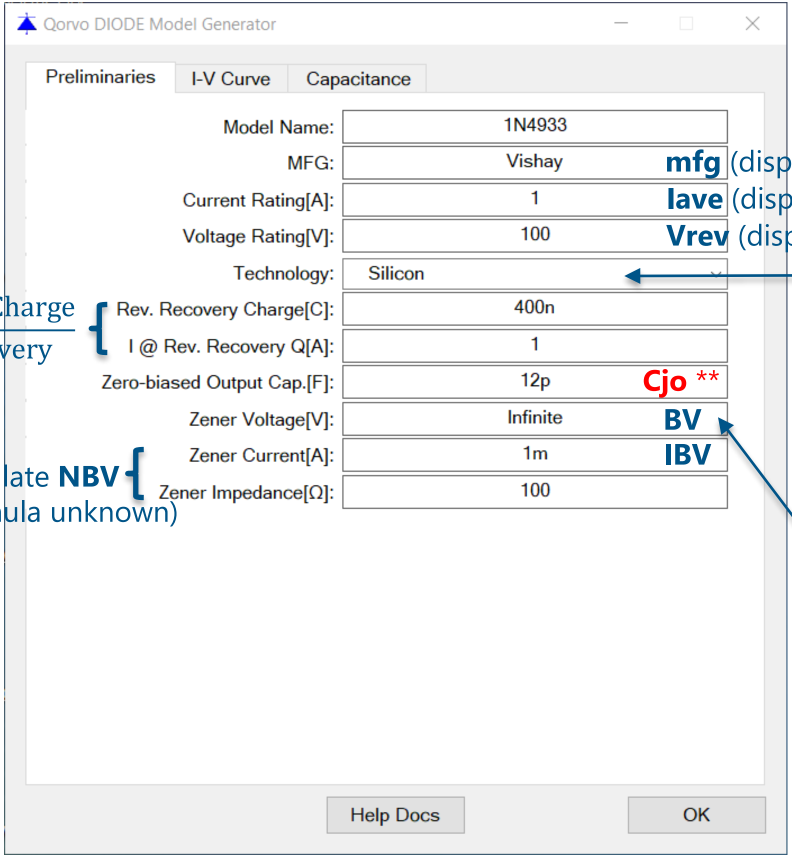
DIODE.exe

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)

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

Cjo **

BV

IBV

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

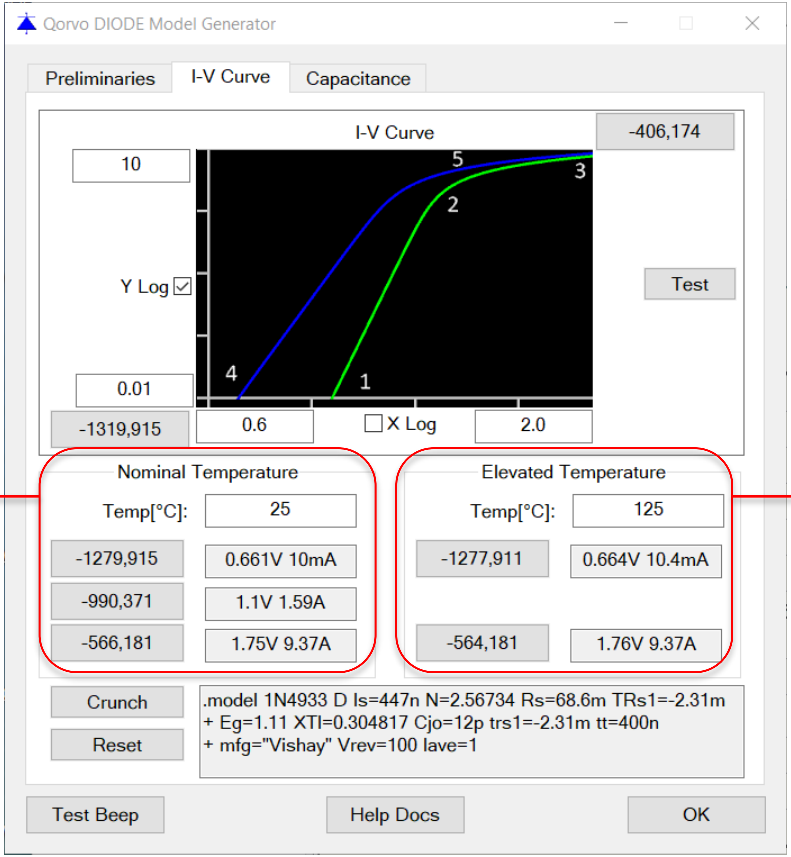
BV, **IBV**, **NBV** will be generated is this box is non-zero

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**



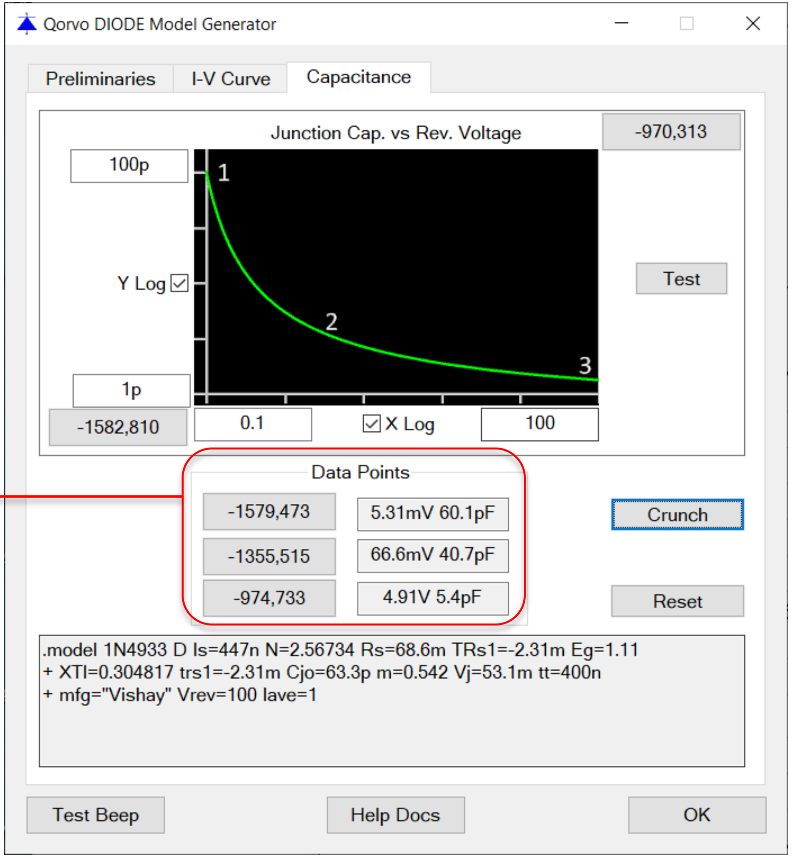
Determine **TRs1, XTI**

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

(If XTI=3, TRs1 may not generated)

Diode Model Generator – Capacitance Tab

Determine : Cjo, m, Vj



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

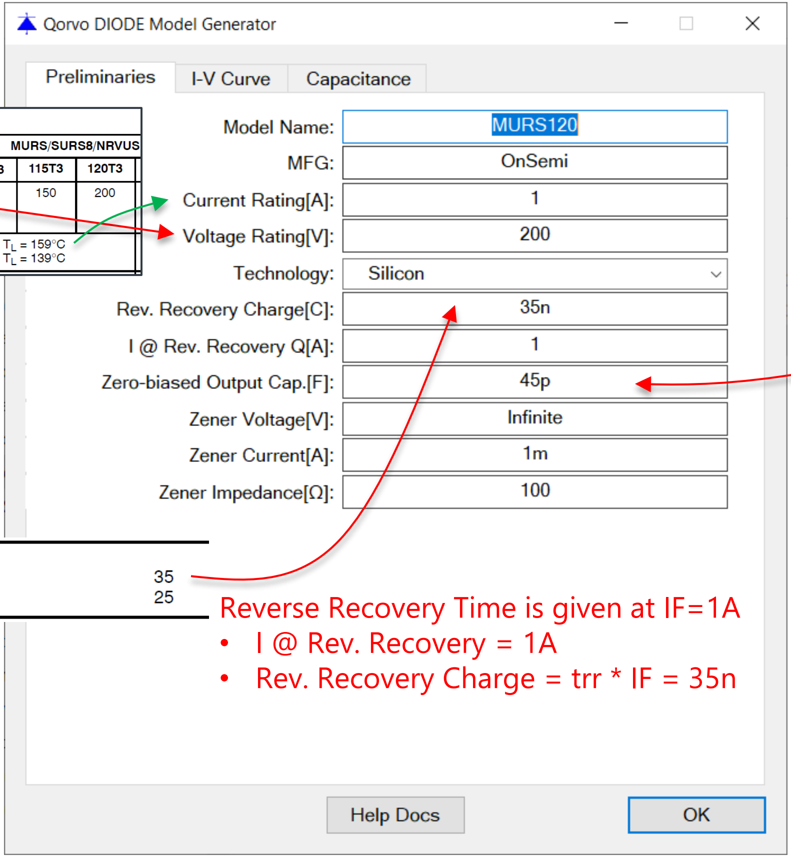
Diode Model Generator

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

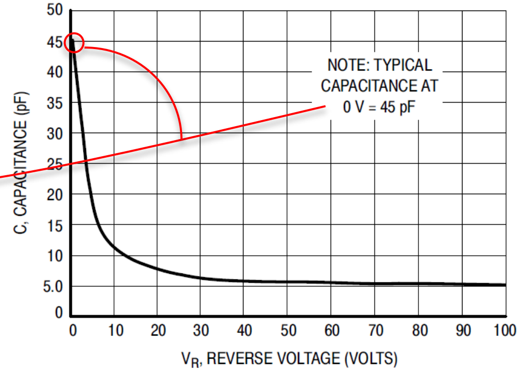


Figure 3. Typical Capacitance

Example – Onsemi MURS120 Datasheet to Model Generator

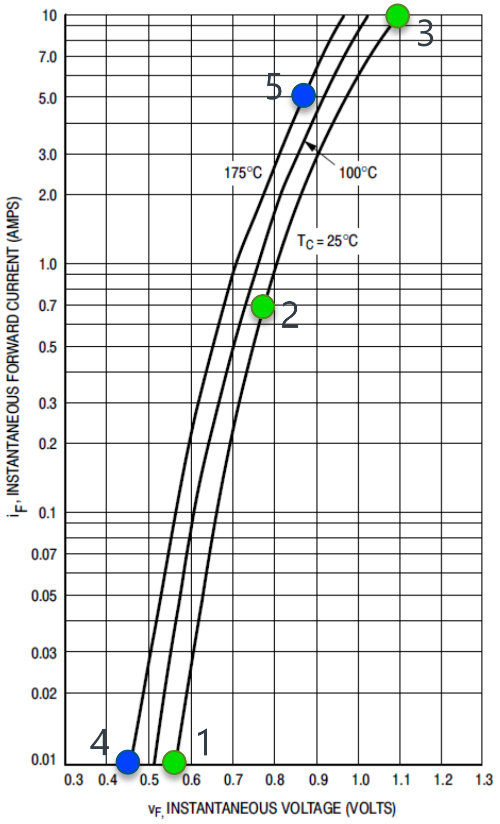
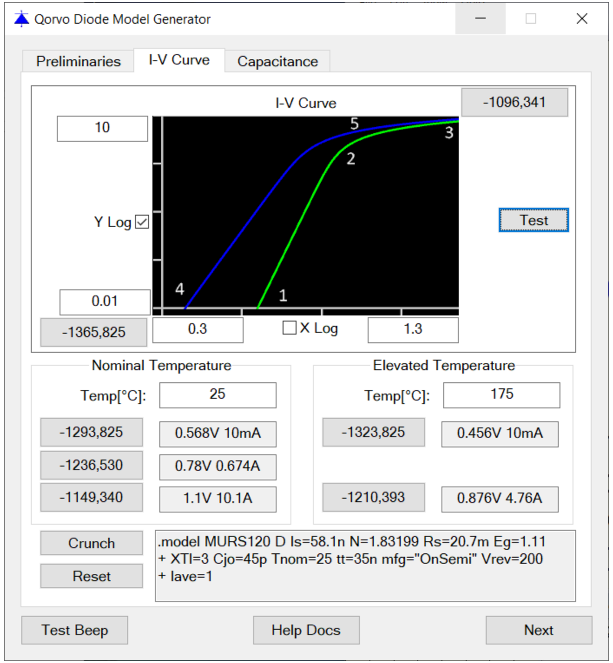
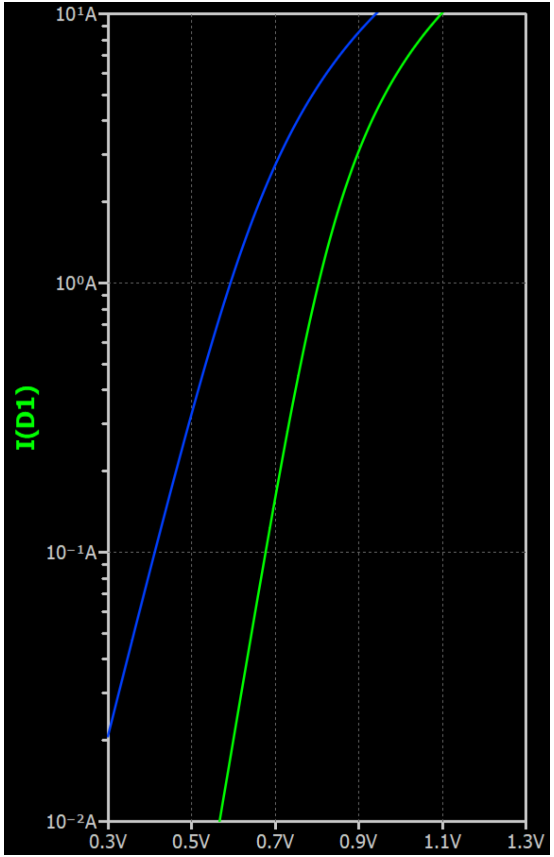


Figure 1. Typical Forward Voltage





Example – Onsemi MURS120 Datasheet to Model Generator

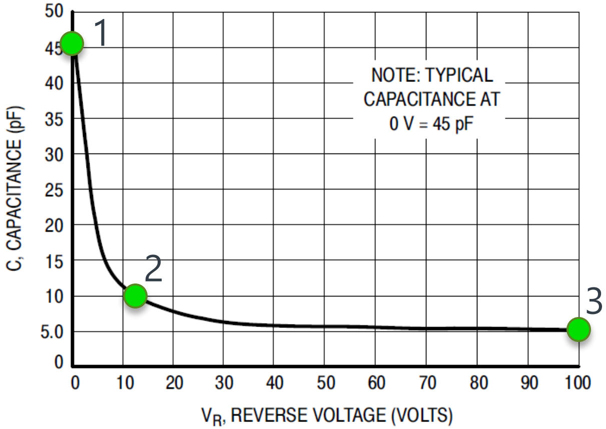
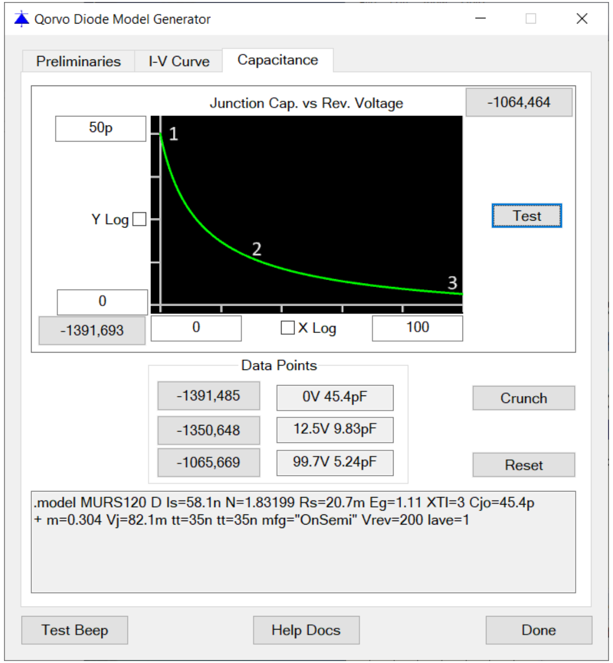
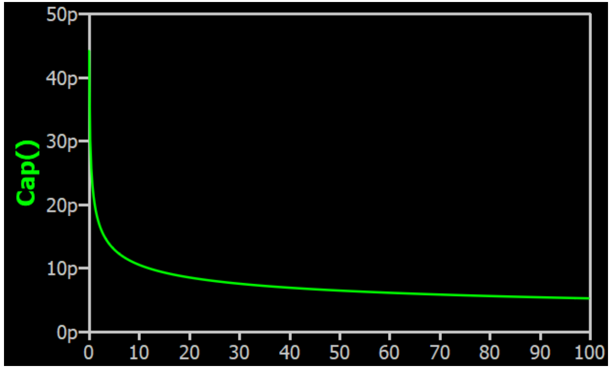


Figure 3. Typical Capacitance





Diode Model Generator

Example – Datasheet of Microchip APT15D100BCT

Example – Microchip APT15D100BCT Datasheet to Model Generator

MAXIMUM RATINGS

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
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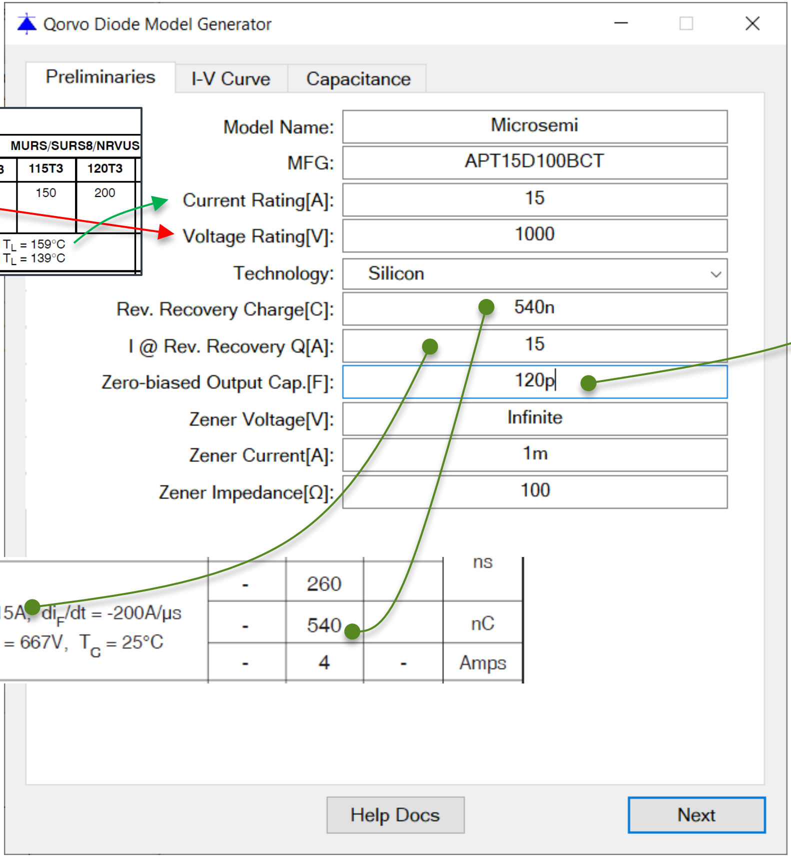


t_{rr}	Reverse Recovery Time	I_F = 15A, di_F/dt = -200A/μs V_R = 667V, T_C = 25°C	-	260		ns
Q_{rr}	Reverse Recovery Charge		-	540		nC
I_{RRM}	Maximum Reverse Recovery Current		-	4	-	Amps

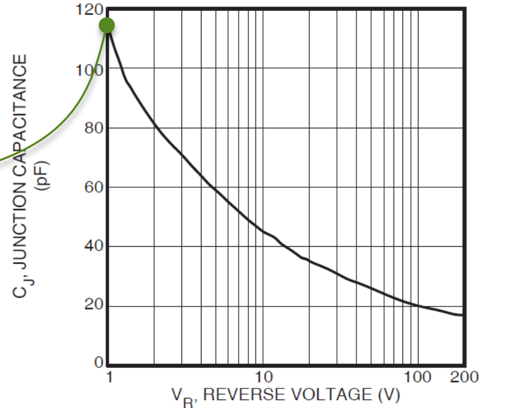


Figure 8. Junction Capacitance vs. Reverse Voltage

Example – Microchip APT15D100BCT Datasheet to Model Generator

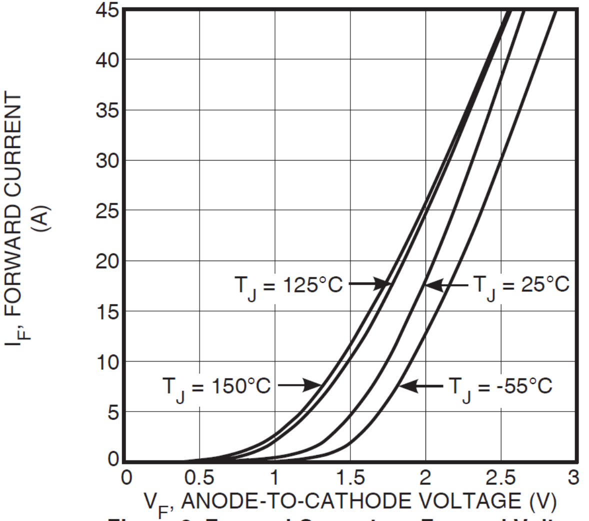
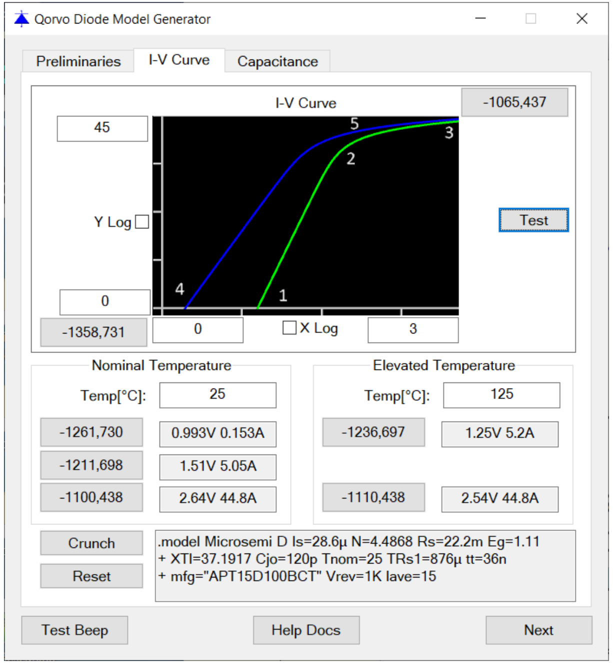
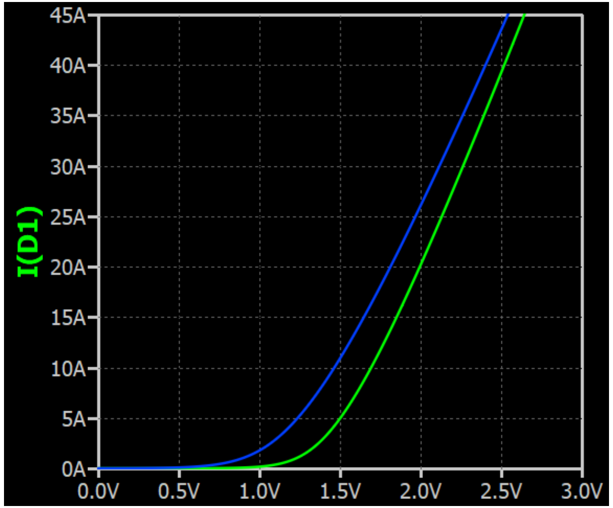


Figure 2. Forward Current vs. Forward Voltage





Example – Microchip APT15D100BCT Datasheet to Model Generator

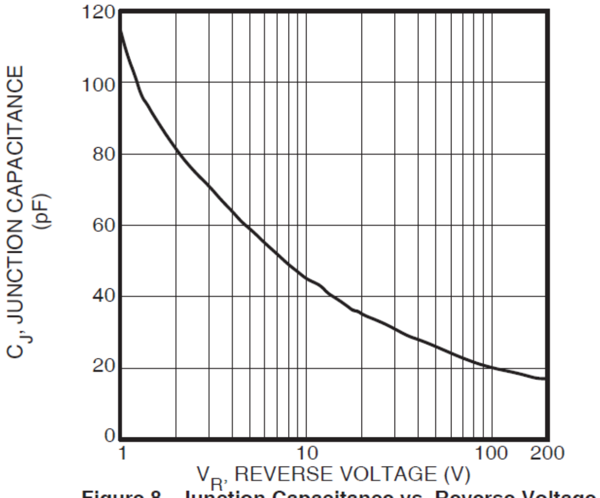
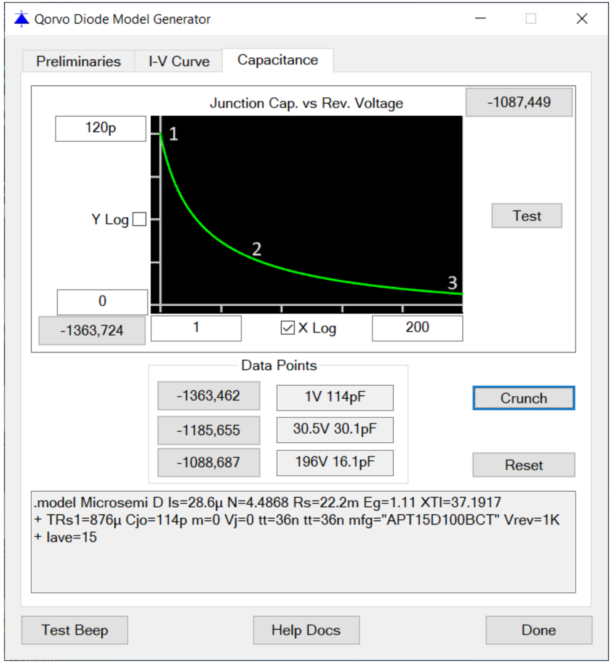
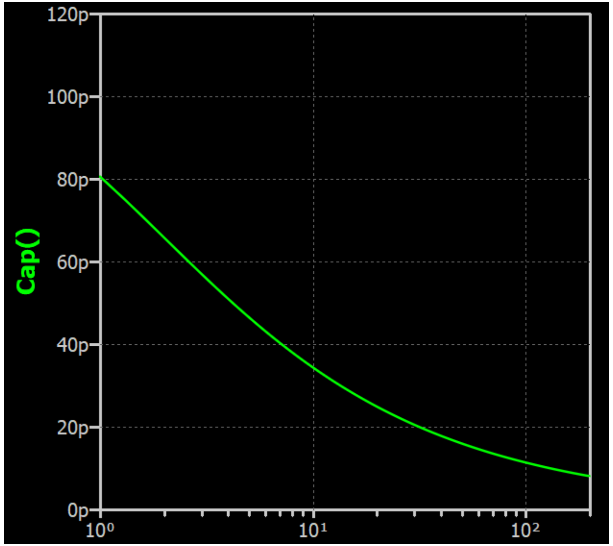


Figure 8. Junction Capacitance vs. Reverse Voltage





MOSFET Model Generator

MOSFET.exe

MOSFET Model Generator

Parameters Generation

MOSFET Model Generator – Preliminaries Tab

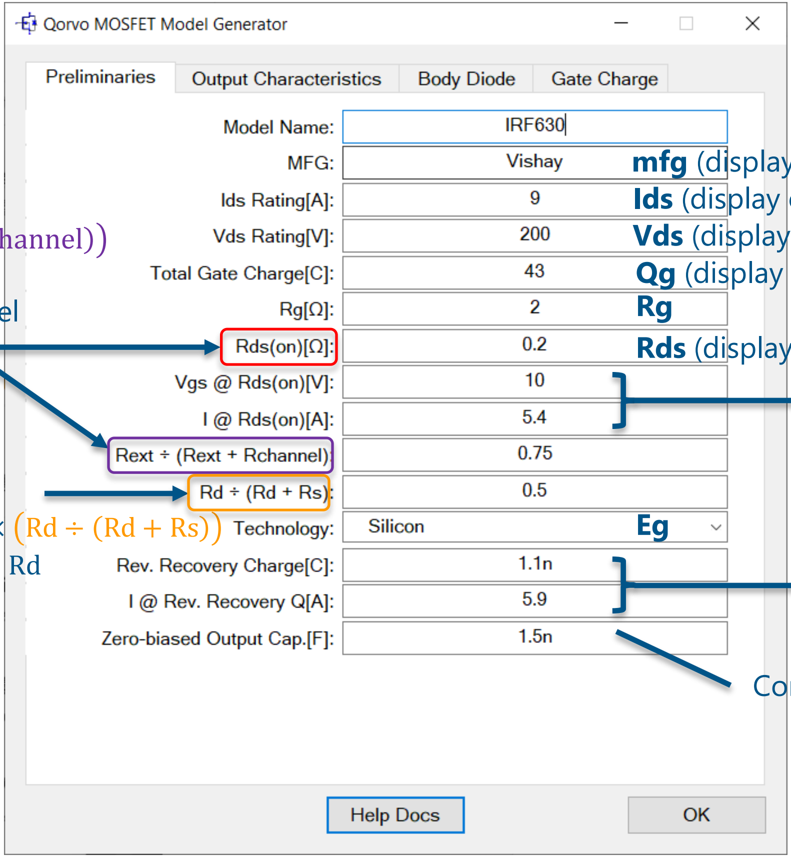
Determine : mfg, Ids, Vds, Qg, Rg, Rds, Rd, Rs, Eg, tt

$\text{Rd+Rs} = \text{Rds(on)} \times (\text{Rext} \div (\text{Rext} + \text{Rchannel}))$

- Rext = Rd + Rs
- Rchannel is Rds of MOSFET channel

$\textbf{Rd} = \text{Rds(on)} \times (\text{Rext} \div (\text{Rext} + \text{Rchannel})) \times (\text{Rd} \div (\text{Rd} + \text{Rs}))$

$\textbf{Rs} = \text{Rds(on)} \times (\text{Rext} \div (\text{Rext} + \text{Rchannel})) - \text{Rd}$



mfg (display only)

Ids (display only)

Vds (display only)

Qg (display only)

Rg

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

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

Eg

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

Contribute to Calculation of **Cjo**

Representation:

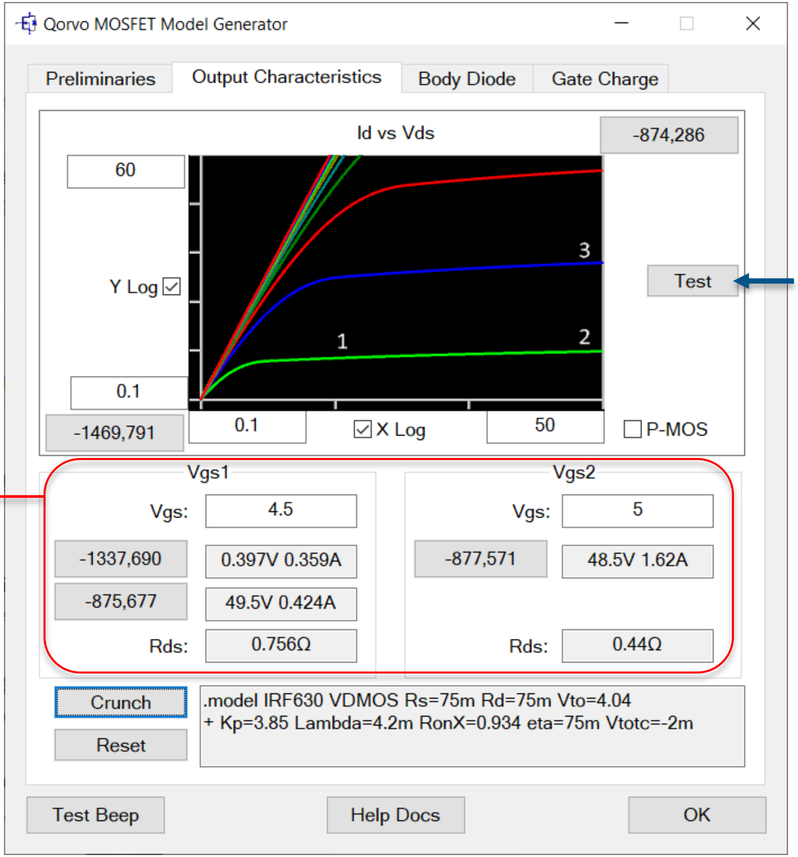
$$\frac{x}{x+y} \to 1 : x \gg y$$

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

MOSFET Model Generator – Output Characteristics

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

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



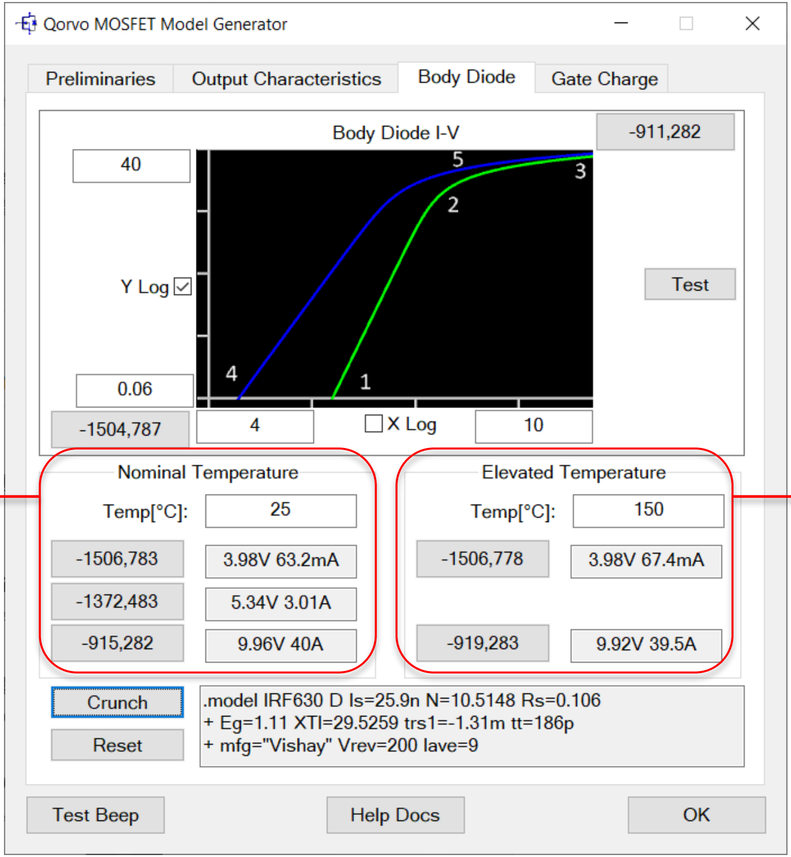
** **Rds,on** in preliminaries tab can be used to fine tuning Id vs Vds curve at lower Vds region

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

MOSFET Model Generator – Body Diode

Determine : Is, N, Rs, TRs1, XTI

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

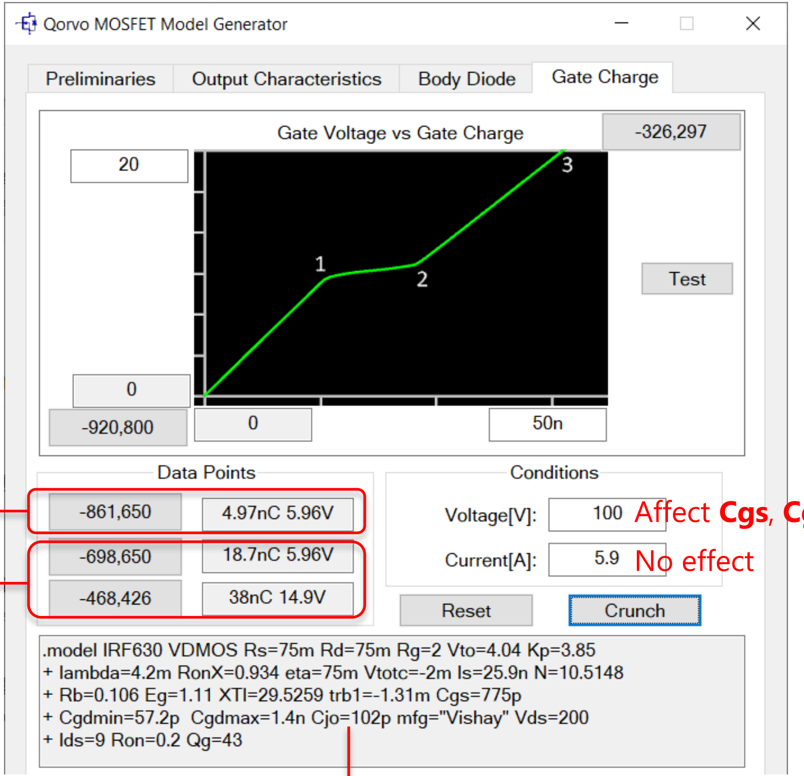


Determine **TRs1, XTI**
If Temp set to be identical nominal temperature, force TRs1=0 and XTI=3

** 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

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]

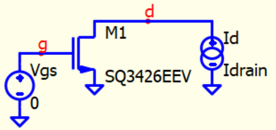
MOSFET Model Generator

Example – Recreate from a model

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

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

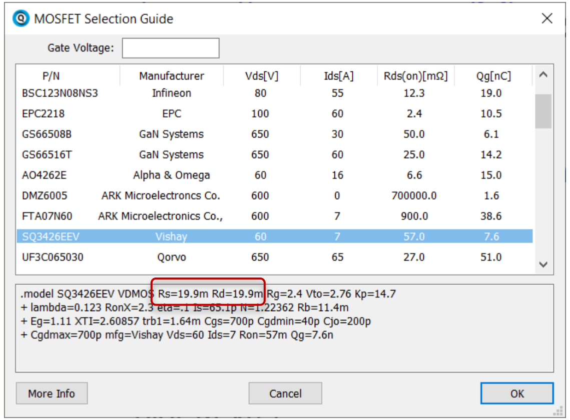
- Rext : Rd + Rs
  - Rds(on) is basically consist of Rext (external resistance : Rd, Rs) and Rchannel (channel resistance)
  - To estimate Rext, fully turn ON a FET model with extreme gate-source voltage, which minimized Rchannel and Rds(on) is dominated by Rext
  - In this example, Rs+Rd=Rext=39.8mΩ.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



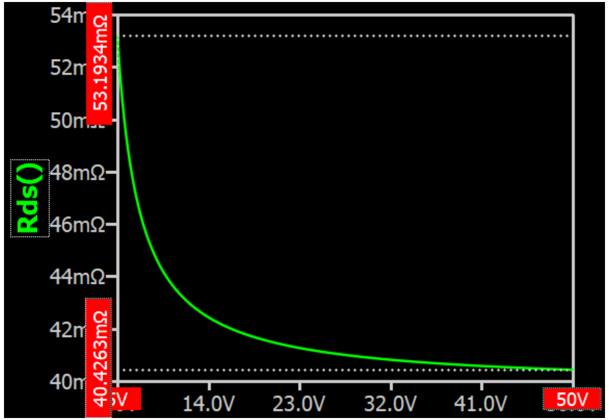
MOSFET Selection Guide

Gate Voltage:

P/N	Manufacturer	Vds[V]	Ids[A]	Rds(on)[mΩ]	Qg[nC]
BSC123N08NS3	Infineon	80	55	12.3	19.0
EPC2218	EPC	100	60	2.4	10.5
GS66508B	GaN Systems	650	30	50.0	6.1
GS66516T	GaN Systems	650	60	25.0	14.2
AO4262E	Alpha & Omega	60	16	6.6	15.0
DMZ6005	ARK Microelectronics Co.	600	0	700000.0	1.6
FTA07N60	ARK Microelectronics Co.,	600	7	900.0	38.6
SQ3426EEV	Vishay	60	7	57.0	7.6
UF3C065030	Qorvo	650	65	27.0	51.0

```
.model SQ3426EEV VDMOS Rs=19.9m Rd=19.9m Rg=2.4 Vto=2.76 Kp=14.7
+ lambda=0.123 RonX=2.3 eta=.1 Is=65.1p N=1.22362 Rb=11.4m
+ Eg=1.11 XTI=2.60857 trb1=1.64m Cgs=700p Cgdmin=40p Cjo=200p
+ Cgdmax=700p mfg=Vishay Vds=60 Ids=7 Ron=57m Qg=7.6n
```

More Info | Cancel | OK

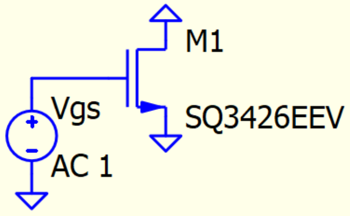


- Now put,
  - Rds(on) = 53.2mΩ
  - Vgs @ Rds(on) = 5V
  - Idrain @ Rds(on) = 1A
  - Rext = Rs+Rd = 40.6mΩ
  - Rchannel@Rds(on)
    = Rds(on) – Rext
    = 53.2mΩ – 40.6mΩ
    = 12.6mΩ
  - Rext÷(Rext+Rchannel)
    = 40.6Ω /(40.6Ω +12.6Ω)
    =0.763Ω

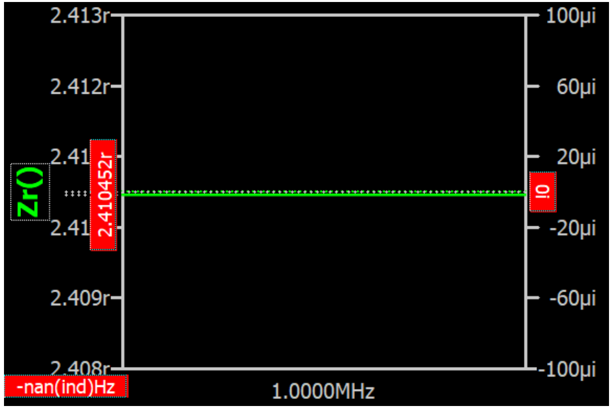
Determine Rg from a MOSFET Model

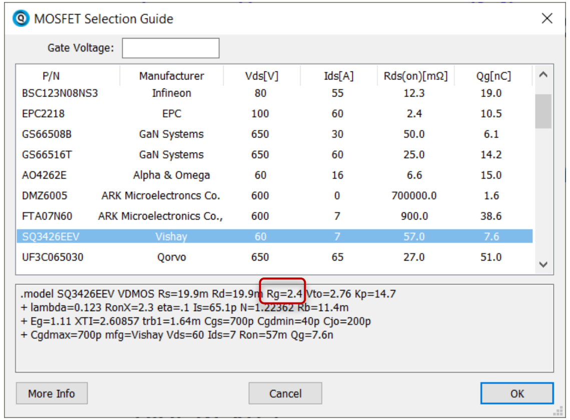
Qspice : Preliminaries - Rg.qsch

- 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()




```
.ac list 1Meg
.func Zr() re(1/-I(Vgs))
.plot Zr()
.meas Rg param Zr()
```





MOSFET Selection Guide

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P/N	Manufacturer	Vds[V]	Ids[A]	Rds(on)[mΩ]	Qg[nC]
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EPC2218	EPC	100	60	2.4	10.5
GS66508B	GaN Systems	650	30	50.0	6.1
GS66516T	GaN Systems	650	60	25.0	14.2
AO4262E	Alpha & Omega	60	16	6.6	15.0
DMZ6005	ARK Microelectronocs Co.	600	0	700000.0	1.6
FTA07N60	ARK Microelectronics Co.,	600	7	900.0	38.6
SQ3426EEV	Vishay	60	7	57.0	7.6
UF3C065030	Qorvo	650	65	27.0	51.0

```
.model SQ3426EEV VDMOS Rs=19.9m Rd=19.9m Rg=2.4 Vto=2.76 Kp=14.7
+ lambda=0.123 RonX=2.3 eta=.1 Is=65.1p N=1.22362 Rb=11.4m
+ Eg=1.11 XTI=2.60857 trb1=1.64m Cgs=700p Cgdmin=40p Cjo=200p
+ Cgdmax=700p mfg=Vishay Vds=60 Ids=7 Ron=57m Qg=7.6n
```

More Info | Cancel | OK

Appendix

Digitize with Crosshair Cursor with Arrow Slight Adjustment

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

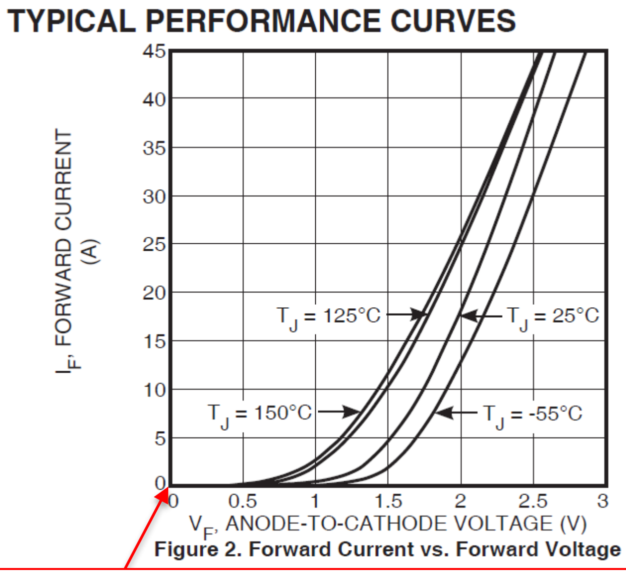
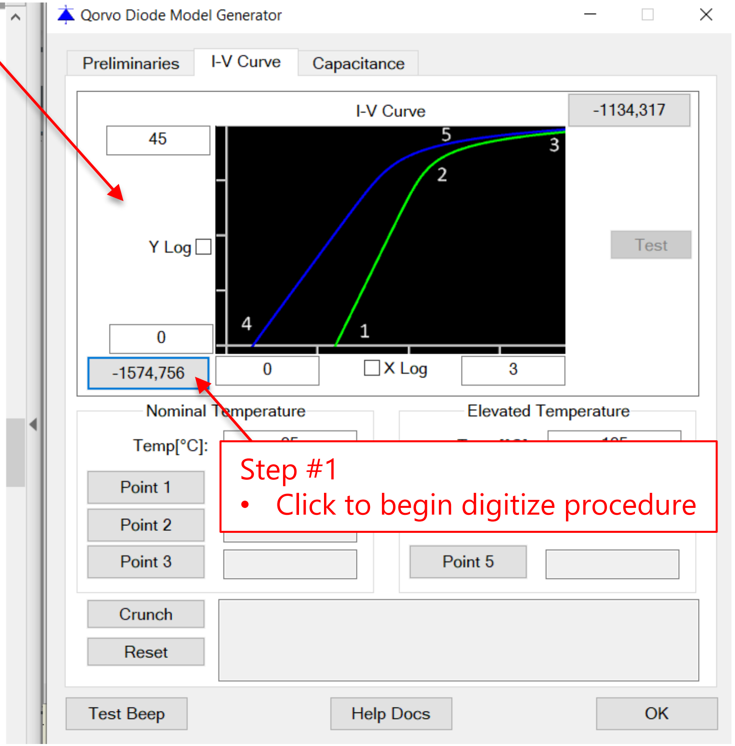


Figure 2. Forward Current vs. Forward Voltage



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]