# Extract Koren Parameters for KT150

VXPhysics.com

## Koren Phenomenological Vac. Tube Spice Models

http://www.normankoren.com/Audio/Tubemodspice_article.html

**Use Mathcad 14:** ***Vacuum Tube SPICE Models.xmcd*** **from VXPhysics.com/Integrated%20Circuits/**

**Koren SpiceTube Parameters**
**Read File Values into "Data":**

Data :=

Koren-Tube Data.xls

Koren's Data does not include KT Spice Model Data for **KT150**

| TUBE | MU | EX | KG1 | KG2 | KP | KVB | CCG | CPG | CCP |
|---|---|---|---|---|---|---|---|---|---|
| 6DJ8 | 28 | 1.3 | 330 | 0 | 320 | 300 | 2.3 | 2.1 | 0.7 |
| 6L6CG | 8.7 | 1.35 | 1460 | 4500 | 48 | 12 | 14 | 0.85 | 12 |
| 6550 | 7.9 | 1.35 | 890 | 4800 | 60 | 24 | 14 | 0.85 | 12 |
| KT88 | 8.8 | 1.35 | 730 | 4200 | 32 | 16 | 14 | 0.85 | 12 |

**Definitions**: MU is the Vp vs Vg Transconductance, KGI is the Ip scale factor, 1/KG, KG2 is $I_{G2}$ scale factor, 1/KG2, KP is a large factor in the Low IP-High Vp Region, KVB is knee voltage for low voltage Ip vs Vp region.

## Koren Triode Model

**Row for 12AX7:** $n := 3$

**Koren Params:** $\left(\mu \;\; Ex \;\; k_{g1} \;\; k_p \;\; k_{vb}\right) := \left(Data_{n,1} \;\; Data_{n,2} \;\; Data_{n,3} \;\; Data_{n,5} \;\; Data_{n,6}\right)$

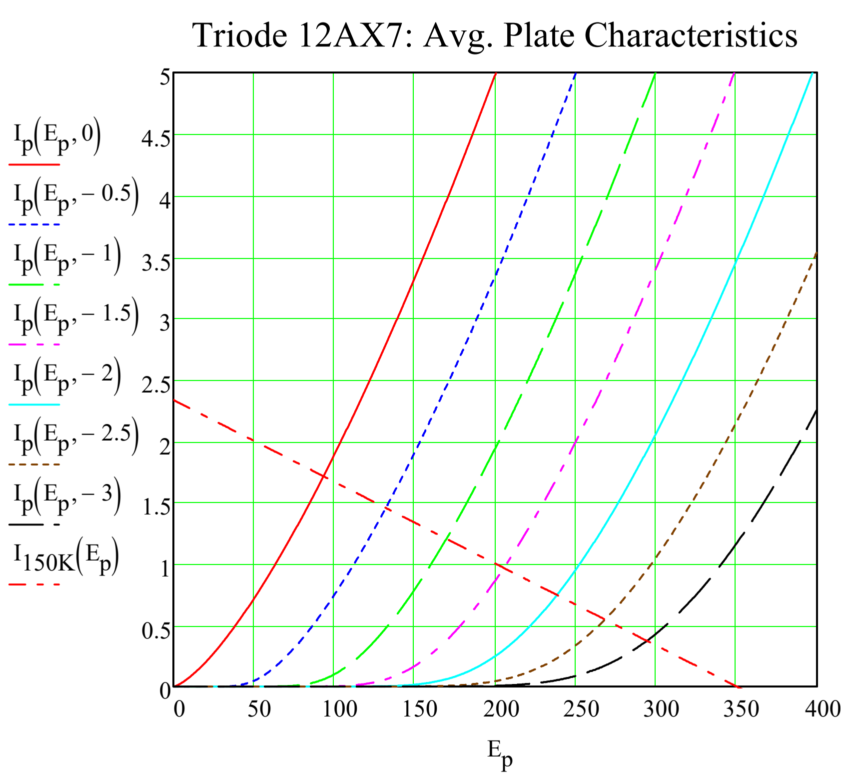
**Koren Model:**

$$E_1(E_p, E_g) := \frac{E_p}{k_p} \ln\left[1 + \exp\left[k_p \cdot \left(\frac{1}{\mu} + \frac{E_g}{\sqrt{k_{vb} + E_p^{\,2}}}\right)\right]\right]$$

$$I_p(E_p, E_g) := 1000 \frac{E_1(E_p, E_g)^{Ex}}{k_{g1}} \left(1 + \mathrm{sign}\left(E_1(E_p, E_g)\right)\right)$$

**150K Load Line:** $I_{150K}(E_p) := (350 - E_p) \cdot \frac{1000}{150000}$

**Plot Koren Triode Model - Fig. 1**



# Koren Pentode Model Ipp vs. Ep/Eg

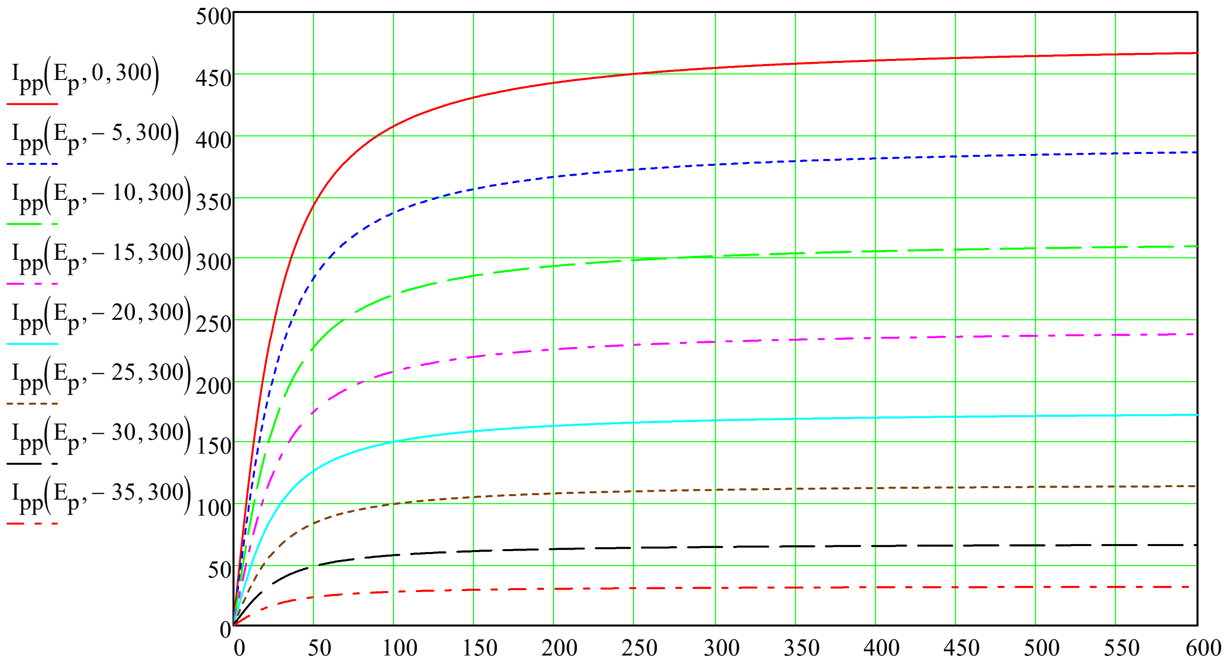
**Row for 6550 in Korens's Spice Data:** $n := 5$

$$\left(\mu \;\; Ex \;\; k_{g1} \;\; k_p \;\; k_{vb}\right) := \left(Data_{n,1} \;\; Data_{n,2} \;\; Data_{n,3} \;\; Data_{n,5} \;\; Data_{n,6}\right)$$

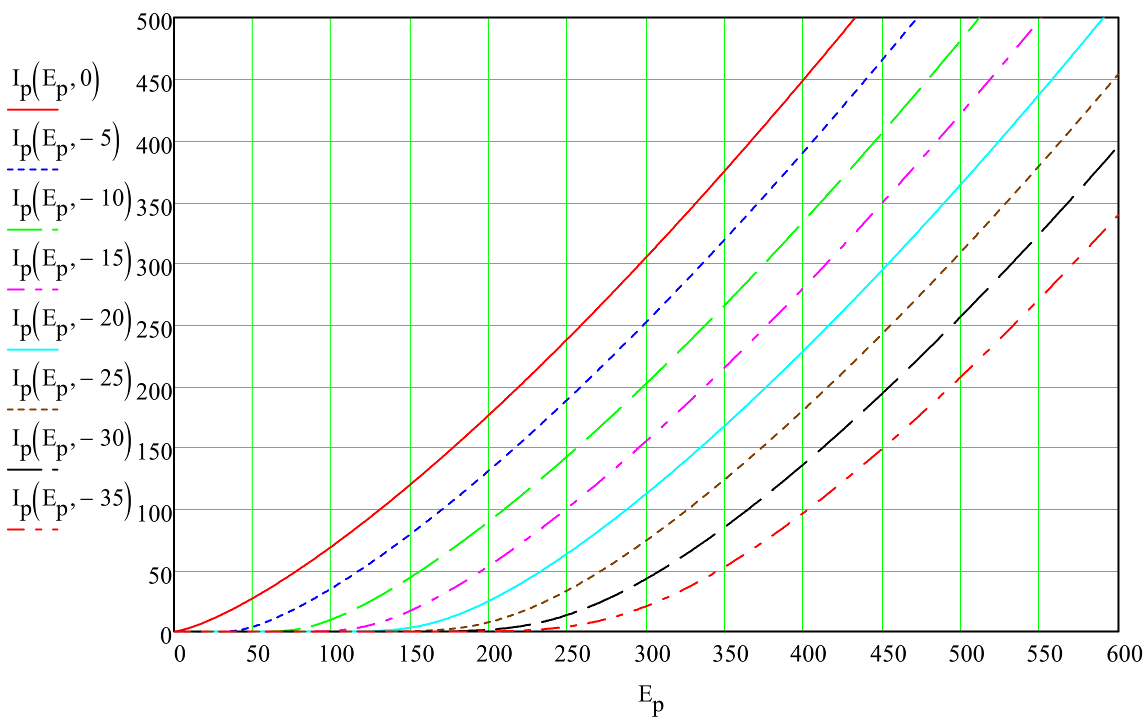
$$E_{1p}(E_g, E_{g2}) := \frac{E_{g2}}{k_p} \ln\left[1 + \exp\left[k_p \cdot \left(\frac{1}{\mu} + \frac{E_g}{E_{g2}}\right)\right]\right]$$

$$I_{pp}(E_p, E_g, E_{g2}) := 1000 \frac{E_{1p}(E_g, E_{g2})^{Ex}}{k_{g1}} \left(1 + \text{sign}\left(E_{1p}(E_g, E_{g2})\right)\right) \cdot \text{atan}\left(\frac{E_p}{k_{vb}}\right)$$

Pentode Mode 6550-A: Avg. Plate Characteristics (mA) - Fig. 2




Triode Mode 6550-A: Avg. Plate Characteristics (mA) - Fig. 3



# Extract Koren SPICE Pentode Parameters for KT150

## KT150 Tung-Sol Published Data

**From: Frank's Electron Tube Pages**

**https://frank.pocnet.net/sheets/084/k/KT150.pdf**

$\mu = \frac{\Delta Ep}{\Delta Eg}$

$r_p = \frac{\Delta Ep}{\Delta Ip}$

$g_m = \frac{\Delta Ip}{\Delta Eg}$

Therefore: $r_p = \frac{\mu}{g_m}$

| | | |
|---|---|---|
| μ, Voltage Multiplier | | |
| Plate Resistance, $r_p$, Approximately | 3000 | Ohms |
| Mutual Transconductance, $g_m$ | 12.6 | ma/V |

**KT150 Interelectrode Capacitance**:

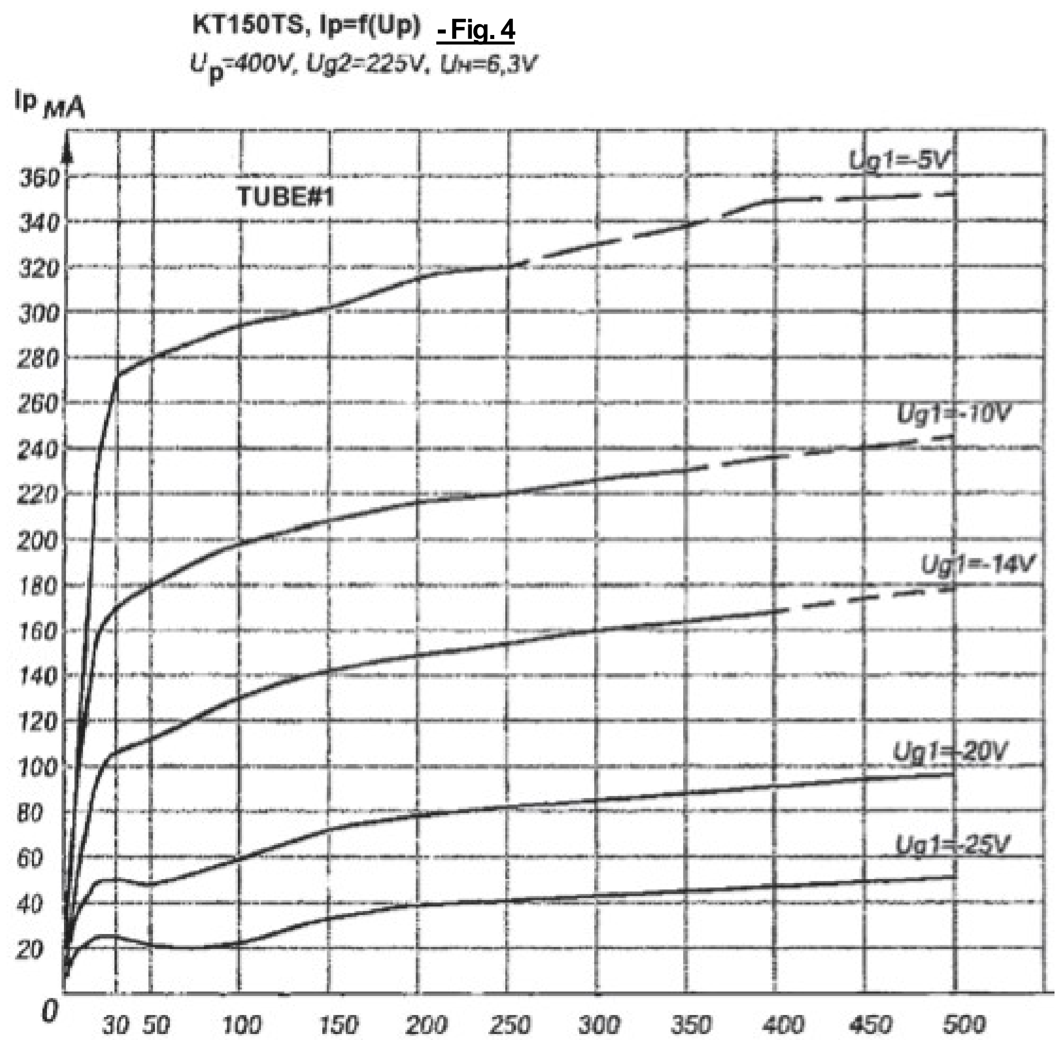
| | | |
|---|---|---|
| Cgp | 1.75 | pf |
| Cinput | 20.5 | pf |
| Coutput | 10 | pf |

# We have a very limited data sample for Ip-Vp Curves

**Note: Published Curve Data is given only at Vg2 = 225V and for just two tubes.**
**Source: www.newsensor.com www.ehx.com**

**Our Data is based on Tube#1, which has the Larger "Premium" Plate Current.**

**Note: The LARGE SLOPE, ΔIp/ΔVp ~ 70mA/300V (Plate Conductance) @Vg1=-5V.**



# Digitize Above Tung-Sol KT150 Tube#1 Curves and get Data Points

**Used "PlotDigitizer_2.6.8_Windows" Program for Digitizing of Above KT150 Curves**

## Read Digitized KT150 Data from TWK Data File from Above 5Vg Curves into Matrix KT

The only data we have is the pentode curves for a fixed screen voltage 225V and five Vgk, grid to cathode values. Points on the curve were digitized, with more points taken on those regions with the greatest bending to capture "kinks" and fewer on the linear regions. A total of 158 Ip - Vpk data point pairs for all the 5 Vgk KT150 curves were recorded and read into the variable KT. Approximately, 32 points per curve, which seemed to best represent the curve, were digitized. The error in the Ip ~300mA/-5V Vgk curve is estimated at ±1.5% and increases to about ± 5% for the smaller Ip ~ 40mA/-25V Vgk curve.
**Using Paint.net graphics software to show the DIFFERENCE between layers of the Tung-Sol and the above digitized Images layer shows a very close image match.**

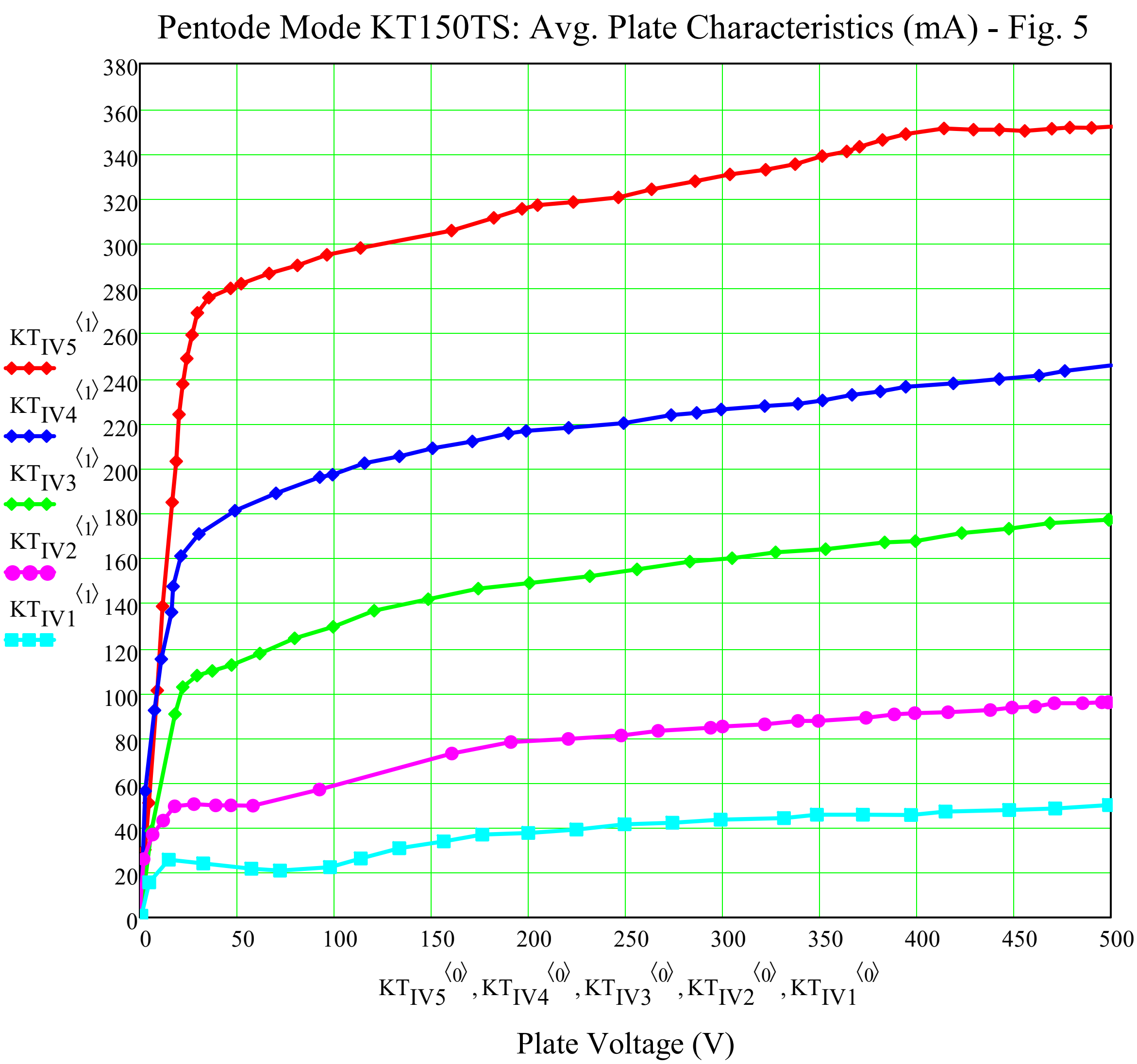
$KT := READPRN("KT150PlotData.txt")$ $rows(KT) = 47$ $cols(KT) = 10$

**Define 5 Plate Current and Voltage Arrays for each of the 5 Grid Voltages: -5 -10, -14, -20, -25 Volts**

$KT_{IV1} := submatrix(KT,0,46,0,1)$ $KT_{IV2} := submatrix(KT,0,46,2,3)$ $KT_{IV3} := submatrix(KT,0,46,4,5)$

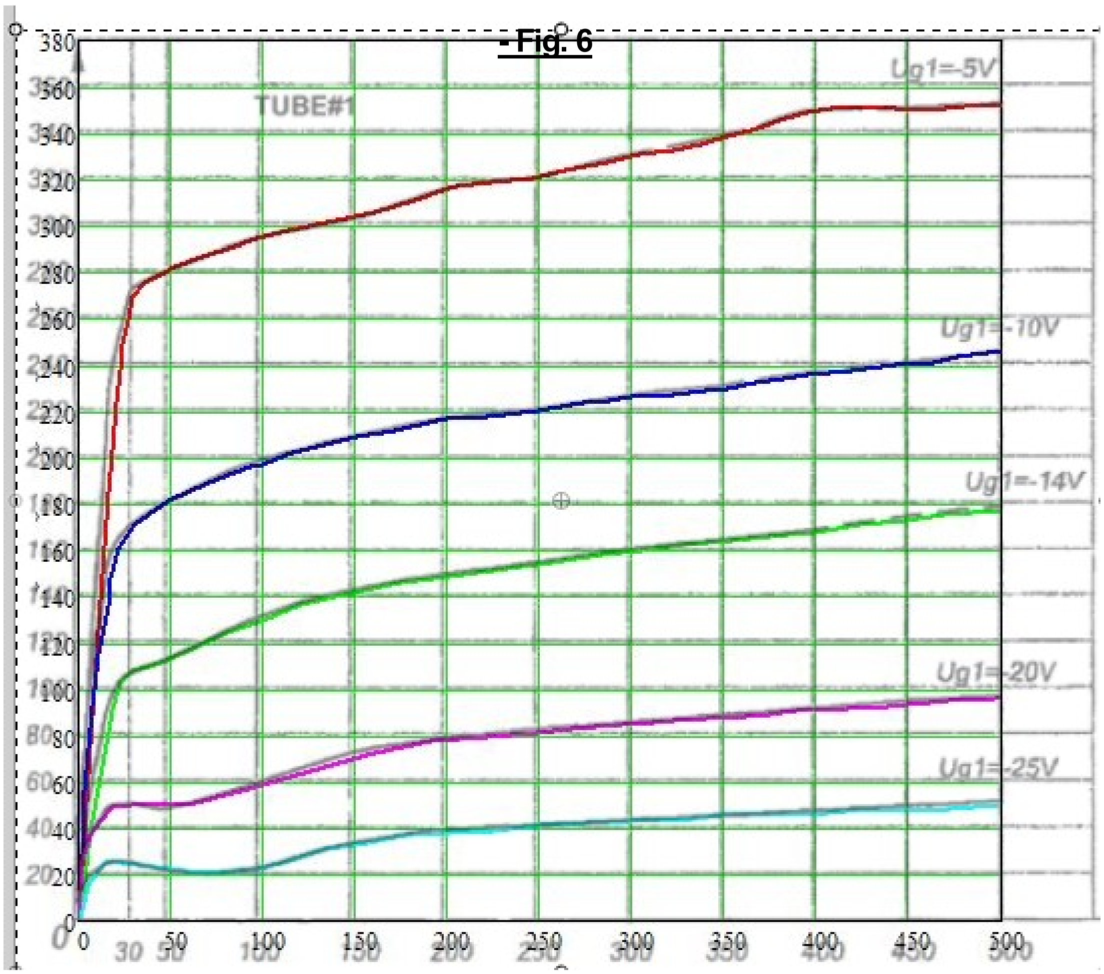
$KT_{IV4} := submatrix(KT,0,46,6,7)$ $KT_{IV5} := submatrix(KT,0,46,8,9)$

## Below are Plots of the Digitized Data
## Vgk = -5, -10, -14, -20, -25V



## Original Tung-Sol Operating Curve Data Superimposed ontop Digitized Curves

**This image shows the Tung-Sol superimposed ontop of the Digitized Curves.**
**Note very close match of digitzed curves except at initial linear portion near origin**




We note some small nonlinearities in the horizontal scale between images.
This may be caused by rotational difference between images.

# Methodology to Extract KT150 Koren Parameters

**Our methodology is similar to Konar's (reference 2), the major difference being we use Mathcad's error minimization function Minerr, and not MATLAB's fmins() error miniminzation tool.**

**Read All Data Points into a 3 Column Array of Vp, Ip, Vg.**
**Used Excel to remove any duplicate data points by Ip. Store Columns into the Data File:** "KT150DigPlotVIG.txt"
**Read into the 3 Column Vp, Ip, Vg Array, $KT_{VIG}$:**

$$KT_{VIG} := \text{READPRN}(\text{"KT150DigPlotVIG.txt"}) \qquad \text{rows}(KT_{VIG}) = 158$$

## Define Koren Plate Current Fitting Function Ipf for Above 5 Grid Voltages Curves

**To reflect compatibility with Child-Langmuir $Vpk^{3/2}$ Law for Thermionic Emission**

**Set Ex in the Model $I_{pf}(E_x, \mu, k_{xx})$ to the Same Value as for a KT88, that is, Ex = 1.35**

Vg2 = 225V

$$E_{1pf}(E_g, \mu, k_p) := \frac{225}{k_p} \ln\left[1 + \exp\left[k_p \cdot \left(\frac{1}{\mu} + \frac{E_g}{225}\right)\right]\right]$$

$$I_{pf}(E_p, E_g, \mu, k_{g1}, k_p, k_{vb}) := 1000 \frac{E_{1pf}(E_g, \mu, k_p)^{1.35}}{k_{g1}} \left(1 + \mathrm{sign}\left(E_{1pf}(E_g, \mu, k_p)\right)\right) \cdot \mathrm{atan}\left(\frac{E_p}{k_{vb}}\right)$$

**Initial Guess (6550 Params):**

$n = 5$

$$(\mu \ \ k_{g1} \ \ k_p \ \ k_{vb}) := (Data_{n,1} \ \ Data_{n,3} \ \ Data_{n,5} \ \ Data_{n,6})$$

$$(\mu \ \ k_{g1} \ \ k_p \ \ k_{vb}) = (7.9 \ \ 890 \ \ 60 \ \ 24)$$

**Check Param Guess for Reasonableness:** $I_{pf}(500, -5, \mu, k_{g1}, k_p, k_{vb}) = 242.627$

## Use Levenberg-Marquardt Method: Minimize Least Squares Error to Plate Current

Define a Residual to be the difference between the current data points $KT_{VIG}$ and Model $I_{pf}(E_x, \mu, k_{xx})$
Given the Plate Voltage - Current - Grid Voltage in Matrix $KT_{VIG}$

$$Residual(\mu, k_{g1}, k_p, k_{vb}) := KT_{VIG}^{\langle 1 \rangle} - \overrightarrow{I_{pf}\left(KT_{VIG}^{\langle 0 \rangle}, KT_{VIG}^{\langle 2 \rangle}, \mu, k_{g1}, k_p, k_{vb}\right)}$$

**Condition to Minimumize the Residual Least Squares Fit Error Using L-V Minerr Method**

Given

$$0 = Residual(\mu, k_{g1}, k_p, k_{vb})$$

**Use Minerr to Extract Optimumal Parameters**: $(u \ \ kg1 \ \ kp \ \ kvb) := Minerr(\mu, k_{g1}, k_p, k_{vb})^T$

### Extracted Koren Params: $(u \ \ kg1 \ \ kp \ \ kvb) = (10.774 \ \ 412.457 \ \ 28.64 \ \ 14.226)$

**Put Koren SPICE Params for 5 $V_g$ Curves into Array Sp:** $Sp := (u \ \ kg1 \ \ kp \ \ kvb)^T$

**SSE Error Estimate:** $ERR_{sse} := \sqrt{\sum Residual(u, kg1, kp, kvb)^2 \cdot \frac{1}{158}}$ $ERR_{sse} = 0.905$ **Average Error ~1mA**

**ERR is an Internal Variable that gives L-M SSE Error:** $\frac{ERR}{158} = 0.905$ ERR Same as SSE

**Define Plate Current vs Voltage Function: Ipk(Ep, Vg), using KT150 Koren Spice Params, Sp**

$$Ip_k(E_p, Vg) := I_{pf}(E_p, Vg, Sp_0, Sp_1, Sp_2, Sp_3)$$

**Check at 500V:** $Ip_k(500, -5) = 338.95$

$Ip_k(500, -10) = 229.687$ $Ip_k(500, -14) = 158.873$ $Ip_k(500, -20) = 82.13$ $Ip_k(500, -25) = 43.014$

# Compare Extracted KT150 Koren Model to Digitized Ip-Vp Curve Data

## Digitized Tube Data Shown as Points. Koren Model are Lines

**Note Again, that these Parameters are based on a Very Limited Data Sample**

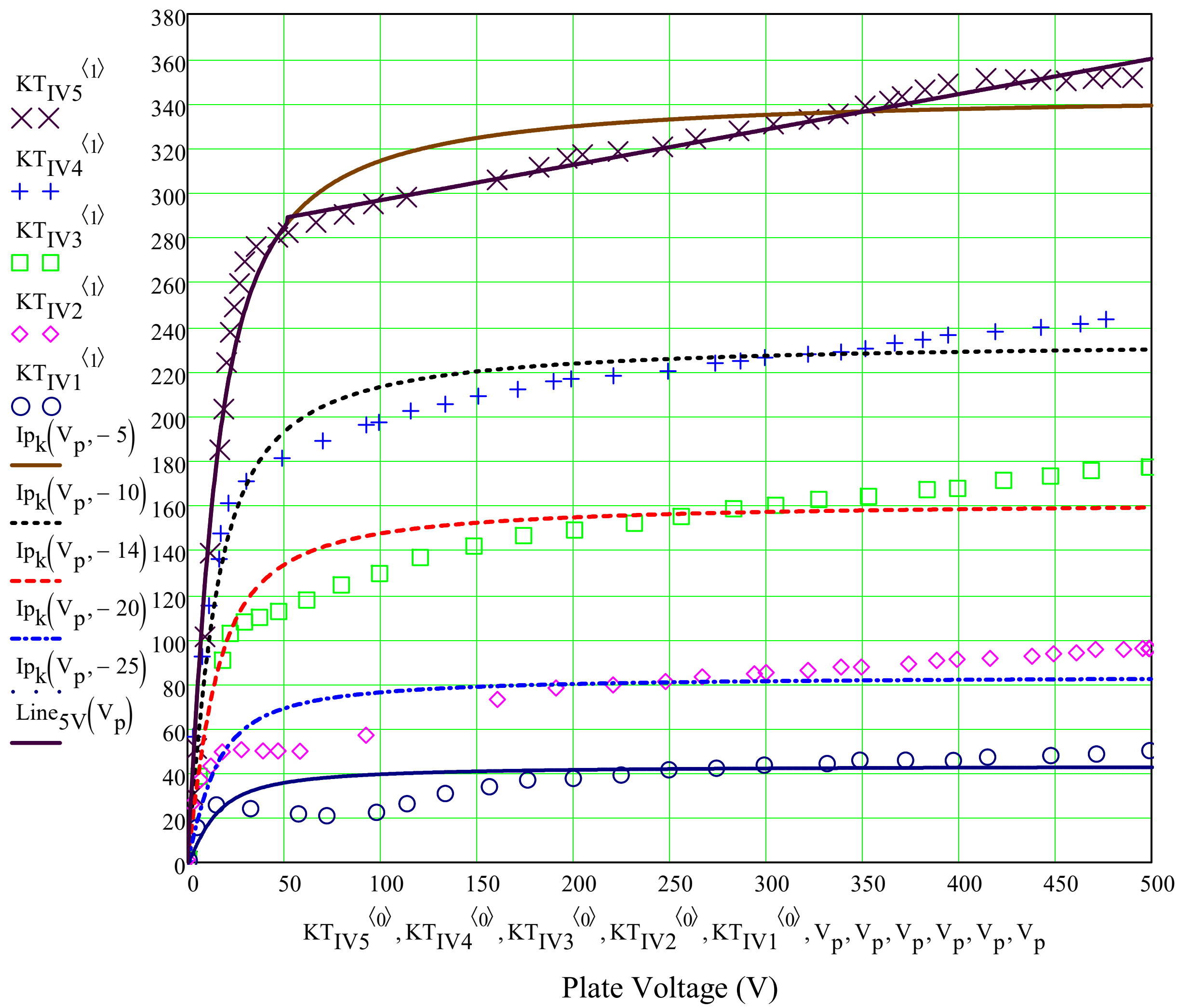
**Extracted KT150 Koren Parameters:** $(u \;\; kg1 \;\; kp \;\; kvb) = (10.774 \;\; 412.457 \;\; 28.64 \;\; 14.226)$

**Find the line that best matches the Slope of the -5V Digitzed Data curve between Vp 50 to 400V.** Create an Array **VI5A** for the digitized VI values of -5V data from 100 to 400V.

$ab := \text{line}\left(VI5A^{\langle 0 \rangle}, VI5A^{\langle 1 \rangle}\right)$ $\qquad Line_{5V}(Vp) := \text{if}\left(Vp > 51.6, ab_0 + ab_1 \cdot Vp, Ip_k(Vp, -5)\right)$

$V_p := 0, 1 .. 500$

Pentode Mode KT150TS: Avg. Plate Characteristics (mA) - Fig. 7




**Inspection of the above KT150 plots show that except for matching the Ip-Vp Plate Conductance line, Line5V(Vp), there is a reasonably good match between Koren's SPICE model and the digitized data.**

## Lets do an Improved Model of the ΔIp/ΔVp Slope

# Characterize Slope of ΔIp/ΔVp or Plate Conductance, Gp

We will use the above digitized KT curves to measure the slope (ΔI/ΔV) of the curves. Select data in the KT curves between **100 and 400V** Vpk and put then into **Arrays** named **VIxx**, where xx is the **-**gate voltage. Then the plate resistance, ΔV/ΔI, is 1/slope of Ip-Vp curve. Thus for VIxx, the function rp(VI) below gives rp.

**The Mathcad slope() function gives the best fit value to the VI values**

$G_p(VI) := \text{slope}\left(VI^{\langle 0\rangle}, VI^{\langle 1\rangle}\right)$

Plate conductance, $G_{p,}$ is defined as ratio of the change of plate current to change in plate voltage $G_p = \frac{\Delta Ip}{\Delta Vp}$

Plate resistance, $r_{p,}$ is defined as ratio of the change of plate voltage to change in plate current $r_p = \frac{\Delta Ep}{\Delta Ip}$ for constant gird to plate voltage.

Since transconductance, μ, is defined as $\mu = \frac{\Delta Ep}{\Delta Eg}$ for constant Ip.

and mutual condictance, $g_m$, is defined as $g_m = \frac{\Delta Ip}{\Delta Eg}$ for constant Ep.

then $r_p$ is equal to $r_p = \frac{\mu}{g_m}$

**We want to Characterize the ΔI/ΔV slope (Plate Conductance, Gp) of the lines in the digitzed data**

The Gate voltages (VgA) for VIxx Arrays of KT150 Digitized Data are: $VgA := (5\ \ 10\ \ 14\ \ 20\ \ 25)^T$

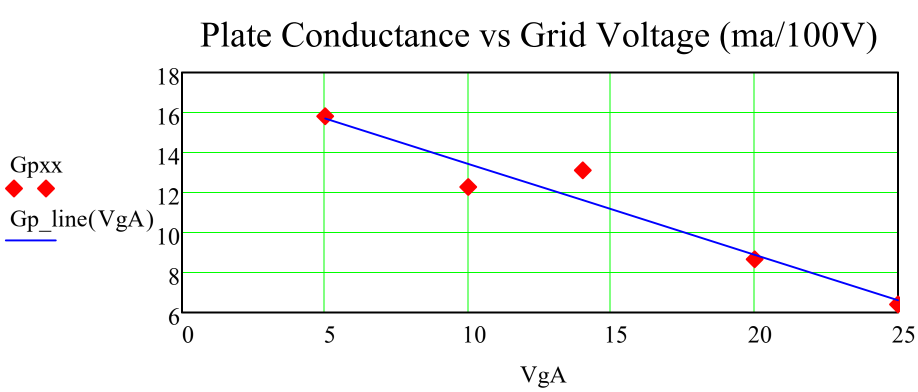
Plate Conductance, Gp, (ΔI/ΔV) slope **between 50 and 500V** for the VIxx arrays is given by the "slope" function" Gp(VI), The above will give units of mA/volt. This is very small.
To **make the units more managable**, give this in **units of mA/100V**; $Gp(VI) := \text{slope}\left(VI^{\langle 0\rangle}, VI^{\langle 1\rangle}\right)\cdot 100$

$Gp(VI5A) = 15.844$ $Gp(VI10A) = 12.482$ $Gp(VI14A) = 13.088$ $Gp(VI20A) = 8.655$ $Gp(VI25A) = 6.436$

Put the above values into the Array Gpxx $Gpxx := (15.8\ \ 12.28\ \ 13.1\ \ 8.65\ \ 6.4)^T$

Fit these to the best fit line and plot. $GM := \text{line}(VgA, Gpxx)$ $Gp\_line(Vg) := GM_0 + GM_1 \cdot Vg$

**We can Approximate Plate Conductance, Gp, vs. Grid Voltage with a Linear Model**




$GM^T = (17.974\ \ -0.455)$

**Similarly, we can get the plate resistance, rp = ΔV/ΔI, which is the reciprocal of the slope (1/slope) of the Ip-Vp curve.** $rp(VI) := \frac{1}{\text{slope}\left(VI^{\langle 0\rangle}, VI^{\langle 1\rangle}\right)}$

**Use the above rp(VI) slope function to calculate the Array Plate Resistance in k ohms for best fit line. From below, we see that rp increases with Vg and thus decreases with Plate Current, Ip:**

$rp(VI5A) = 6.311$ $rp(VI10A) = 8.012$ $rp(VI14A) = 7.641$ $rp(VI20A) = 11.554$ $rp(VI25A) = 15.537$

Put the above rp values into the Array Rp

$Rp := (6.3\ \ 8\ \ 7.6\ \ 11.5\ \ 15.5)^T$

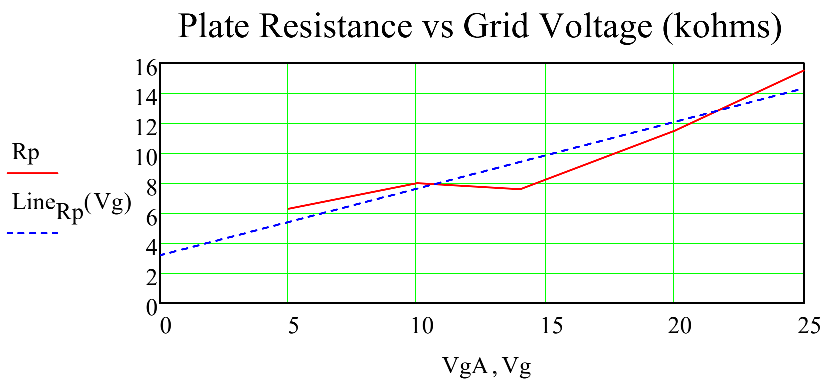
## Consistency Check

Check to see if the Rp valures calculated above are consistent with the earlier calculation of Gp

$$Gp_g := \left(\frac{1}{Rp}\cdot 100\right)^T = (15.873 \quad 12.5 \quad 13.158 \quad 8.696 \quad 6.452)$$

Get the best line fit, $Line_{Rp}$: $AB := \text{line}(VgA, Rp)$ $AB^T = (3.19 \quad 0.445)$ $Line_{Rp}(Vg) := AB_0 + AB_1\cdot Vg$

Fit the best fit line and plot $Line_{Rp2}(Vg) := AB_1\cdot Vg$

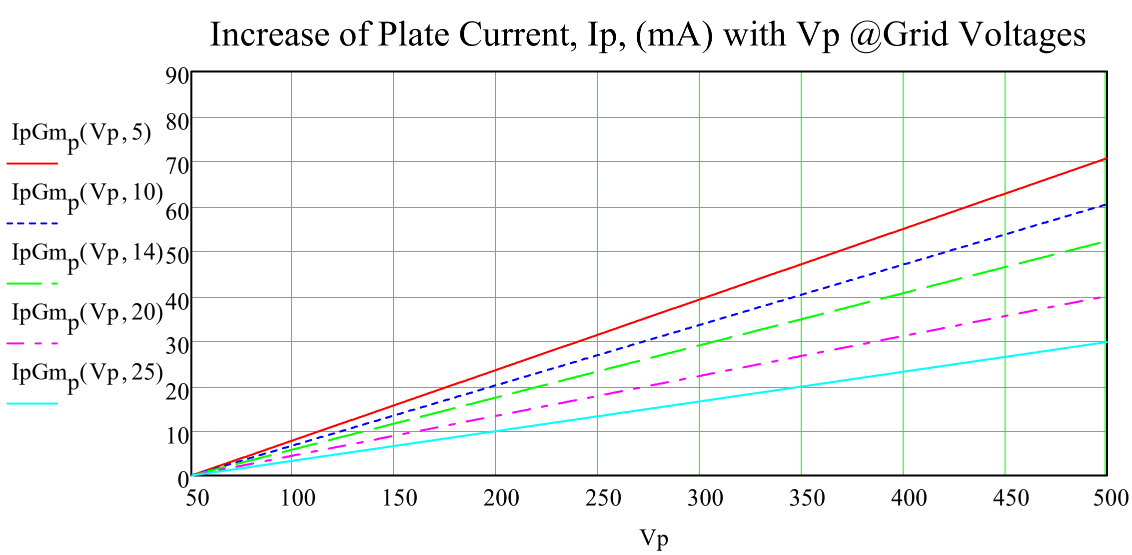



**We can reasonably represent the Large Signal Conductance (ΔI/ΔV) slope of the KT100 curves for the different Gate Voltages with a Linear Model. Using SSE to find best fit parameters should improve the model. We can do either the above Linear Gate Voltage Models for the Plate Conductance, Gp, or for the Plate Resistance, rp. Since a Vacuum Tube is basically a Voltage Controlled Current source, we will use the Plate Conductance, Gp, Model.**

**We Model the Tube with Gp for the ΔIp versus Vp as function of Vg beyond Vp=50V.**

GM is (Intercept, slope) for Gp: $GM^T = (17.974 \quad -0.455)$ $Gp\_line(Vg) := GM_0 + GM_1\cdot Vg$

$$IpGm_p(Vp, Vg) := \frac{(Vp - 50)\cdot Gp\_line(Vg)}{100}$$

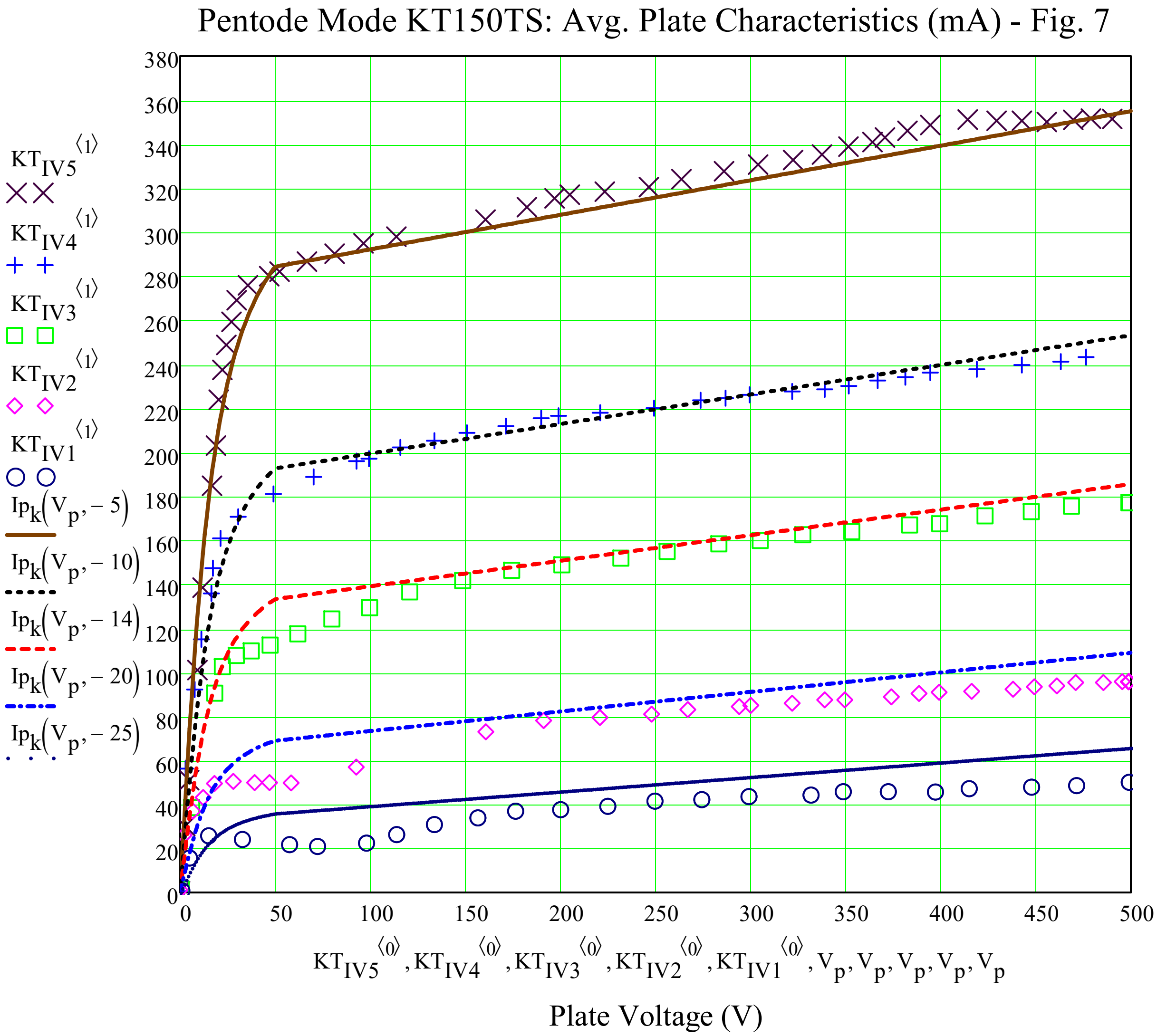


## Linear Model for Plate Conductance. Gp, from Above

$$Gp\_line(Vg) := GM_0 + GM_1 \cdot Vg$$

$$IpGm_p(Vp, Vg) := \frac{(Vp - 50) \cdot Gp\_line(Vg)}{100}$$

$$Ip_k(Vp, Vg) := \text{if}\left(Vp < 50, Ip_k(Vp, Vg), Ip_k(50, Vg) + IpGm_p(Vp, -Vg)\right)$$




$$ResidNew := KT_{VIG}^{\langle 1 \rangle} - \overrightarrow{Ip_k\left(KT_{VIG}^{\langle 0 \rangle}, KT_{VIG}^{\langle 2 \rangle}\right)}$$

$$ERR3 := \sqrt{\sum ResidNew^2 \cdot \frac{1}{158}} = 0.773$$

**Percent Error Improvement Over Koren:** $\frac{0.773 - 0.905}{0.905} = -14.586 \cdot \%$

# The Koren Linear Plate Conductance Model Representation

## Define Koren Plate Current Fitting Function Ipf for Above 5 Grid Voltages Curves

**To reflect compatibility with Child-Langmuir Vpk$^{3/2}$ Law for Thermionic Emission**

**Set Ex to the Same Value as for a KT88, that is, Ex = 1.35**

Vg2 = 225V

$$E_{1pf}(E_g,\mu,k_p) := \frac{225}{k_p}\cdot\ln\left[1+\exp\left[k_p\cdot\left(\frac{1}{\mu}+\frac{E_g}{225}\right)\right]\right]$$

$$I_{p0}(E_p,E_g,\mu,k_{g1},k_p,k_{vb}) := 1000\frac{E_{1pf}(E_g,\mu,k_p)^{1.35}}{k_{g1}}\left(1+\text{sign}\left(E_{1pf}(E_g,\mu,k_p)\right)\right)\cdot\text{atan}\left(\frac{E_p}{k_{vb}}\right)$$

$$IpGmp(Vp,Vg,Gp_0,Gp_1) := (Vp-50)\cdot(Gp_0+Gp_1\cdot Vg)\cdot 0.001$$

<-- To avoid small numbers, multipy Gp by 0.001, then Gp is in units of milli Siemens, mS

$$I_{lin}(E_p,E_g,\mu,k_{g1},k_p,k_{vb},Gp_0,Gp_1) := I_{p0}(E_p,E_g,\mu,k_{g1},k_p,k_{vb}) + IpGmp(E_p,-E_g,Gp_0,Gp_1)$$

$$I_{pl}(E_p,E_g,\mu,k_{g1},k_p,k_{vb},Gp_0,Gp_1) := \text{if}\left(E_p<50, I_{p0}(E_p,E_g,\mu,k_{g1},k_p,k_{vb}), I_{lin}(E_p,E_g,\mu,k_{g1},k_p,k_{vb},Gp_0,Gp_1)\right)$$

**Initial Guess (6550 Params):**

$n := 5$

$$(\mu\ \ k_{g1}\ \ k_p\ \ k_{vb}\ \ Gp_0\ \ Gp_1) := \left(Data_{n,1}\ \ Data_{n,3}\ \ Data_{n,5}\ \ Data_{n,6}\ \ 95\ \ \frac{-1}{1}\right)$$

$$(\mu\ \ k_{g1}\ \ k_p\ \ k_{vb}\ \ Gp_0\ \ Gp_1) = (7.9\ \ 890\ \ 60\ \ 24\ \ 95\ \ -1)$$

**Check Param Guess for Reasonableness:** $I_{pl}(500,-5,\mu,k_{g1},k_p,k_{vb},Gp_0,Gp_1) = 283.127$

## Use Levenberg-Marquardt Method: Minimize Least Squares Error to Plate Current

$$Resid(\mu,k_{g1},k_p,k_{vb},Gp_0,Gp_1) := KT_{VIG}^{\langle 1\rangle} - \overrightarrow{I_{pl}\left(KT_{VIG}^{\langle 0\rangle},KT_{VIG}^{\langle 2\rangle},\mu,k_{g1},k_p,k_{vb},Gp_0,Gp_1\right)}$$

**Condition for Minimum Residual Least Squares Fit Error Using L-V Minerr Method**

Given

$$0 = Resid(\mu,k_{g1},k_p,k_{vb},Gp_0,Gp_1)$$

**Use Minerr to Extract Optimumal Parameters:**

$$(u\ \ kg1\ \ kp\ \ kvb\ \ Gp0\ \ Gp1) := Minerr(\mu,k_{g1},k_p,k_{vb},Gp_0,Gp_1)^T$$

## Extracted Koren Params:

$$(u\ \ kg1\ \ kp\ \ kvb\ \ Gp0\ \ Gp1) = (9.953\ \ 484.887\ \ 37.964\ \ 11.302\ \ 94.978\ \ -1.339)$$

**ERR is an Internal Variable that gives L-M SSE Error:**

**Percent Error Improvement Over Koren:**
**This model has 61% less SSE error than Koren's**

$$\frac{ERR}{rows(KT_{VIG})} = 61.24\cdot\%$$

**Define Plate Current vs Voltage Function: Ipk(Ep, Vg), using KT150 Koren Spice Params, Sp**

**Put Koren SPICE Params for 5 $V_g$ Curves into Array Sp:** $Sp := (u\ \ kg1\ \ kp\ \ kvb\ \ Gp0\ \ Gp1)^T$

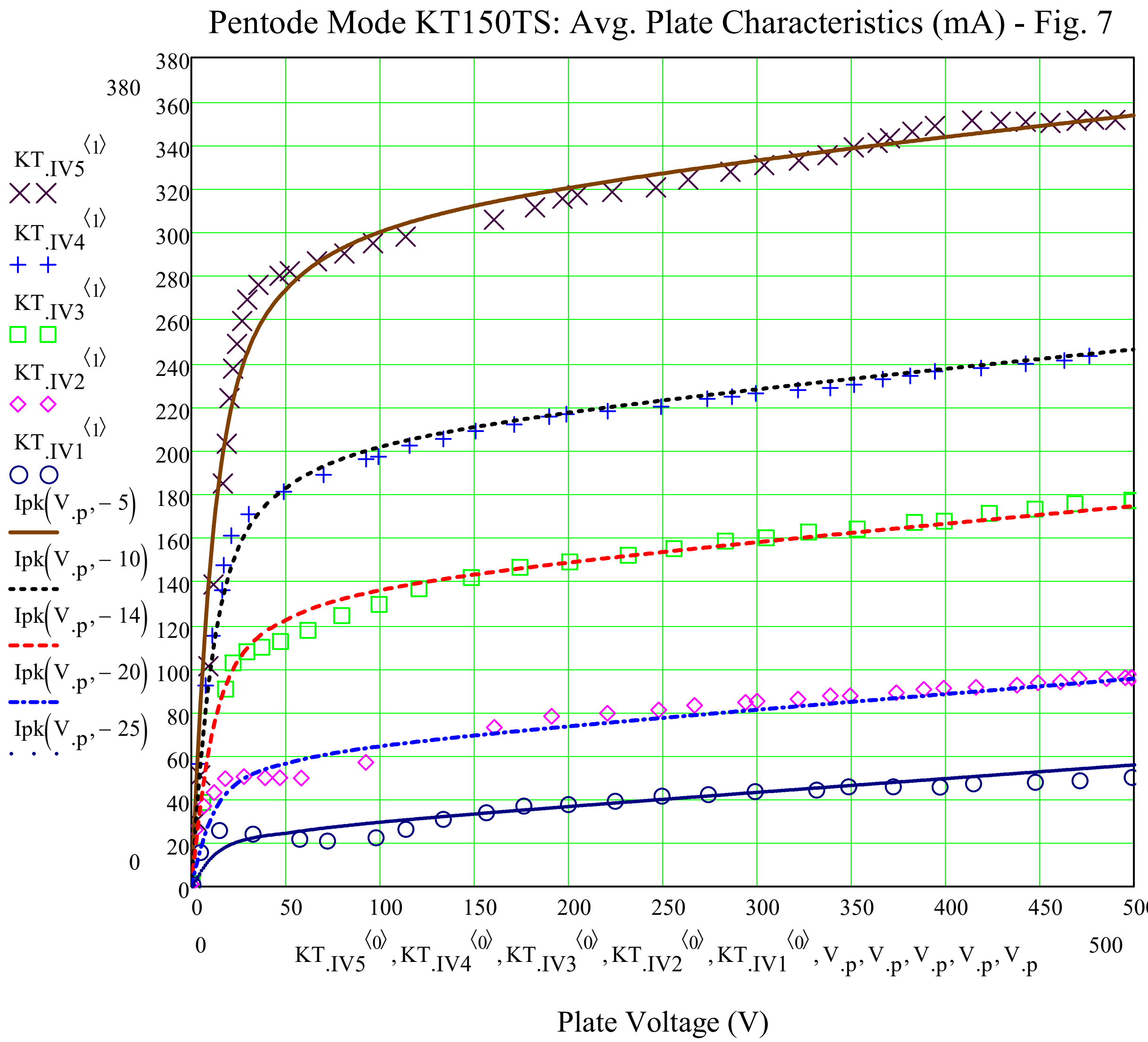
$$Sp^T = (9.953\ \ 484.887\ \ 37.964\ \ 11.302\ \ 94.978\ \ -1.339)$$

$$Ipk(E_p,V_g) := I_{pl}(E_p,V_g,u,kg1,kp,kvb,Gp0,Gp1)$$

**Check at 500V:** $Ipk(500,-5) = 353.51$

$Ipk(500,-10) = 246.233$ $Ipk(500,-14) = 174.418$ $Ipk(500,-20) = 95.299$ $Ipk(500,-25) = 56.206$

# Koren Linear Plate Conductance Model, KT150 Gp




# Model Error Analysis

**The greatest Residual error between the digitized curve and model is @Vg-5V between Vp 20 to 80V.**
**This is also greatest error source for my digitizedization of the Initial Tung-Sol Curves Source Data.**

# Summary

**Koren Type Phenomelogical Model Parameters: KT150 and KT150-Gp**

| TUBE | MU | EX | KG1 | KG2 | KP | KVB | Gpo | Gp1 | CCG | CPG | CCP | RGI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units | | | | | | V | mS | mS | pF | pF | pF | Ohm |
| 6550 | 7.90 | 1.35 | 890 | 4800 | 60.0 | 24.00 | | | 14 | 0.85 | 12 | 1000 |
| KT88 | 8.80 | 1.35 | 730 | 4200 | 32.0 | 16.00 | | | 14 | 0.85 | 12 | 1000 |
| KT150 | 10.77 | 1.35 | 412.46 | 4200 | 28.6 | 14.23 | | | 14 | 0.85 | 12 | 1000 |
| KT150-Gp | 9.95 | 1.35 | 485 | 4200 | 38.0 | 11.30 | 95 | -1.34 | 14 | 0.85 | 12 | 1000 |