How to distinguish the contributions of Vp and Vps.
Load Box Test

Current is injected at this point in the circuit (at the transformer) by a load box load, and measured on all of the paths leaving the transformer.
Load Box Test

Graph showing the relationship between $V_{cc}$ and $V_{p}$. The graph is linear, with $V_{p}$ increasing proportionally as $V_{cc}$ increases.
$K (Vps) = 21\%$
$K(Vp) = 26\%$
Example
Load Box Test

Vp-ref overnight @ time of Vcc maximum.

(0.37, 2.27)

Maximum Vcc overnight

Predicted Vcc based upon Vp
From the Load Box Test

• $R_t = 0.23 \text{ Ohms}$
• $R_f = 0.93 \text{ Ohms}$
• $R_p = 0.32 \text{ Ohms}$
• $K = 28 \%$
• $\Delta CR = 74\%$
From V-Drop Test

\[ K(V_{ps}) = 20\% \]
K (Vps) = 20%
K(Vp) = 28%
0.565 \times 0.20 \ (Vps) = \ 0.11 \ \text{Volts}
1.7 \times 0.28 \ (Vs) = \ 0.48 \ \text{Volts}
0.48 \ V - \ 0.11 \ V = \ 0.37 \ \text{Volts}
Vcc \ \text{max measured} = \ 0.365 \ \text{Volts}
Example
From the Load Box Test

- $R_t = 0.18$ Ohms
- $R_f = 0.97$ Ohms
- $R_p = 0.25$ Ohms
- $K = 21\%$
- $\Delta CR = 90\%$
From V-Drop Test

$K(V_{ps}) = 15\%$

3.75 Volts

1.62 Volts

2.16 Volts

0.56 Volts

11.5 A
Overnight Recording #1, Zoom-In On Time Of Highest Steady State Cow Contact Voltage.

Volts

06/11/14 16:10:32

<table>
<thead>
<tr>
<th>Ch1 ave</th>
<th>Ch2 ave</th>
<th>Ch3 ave</th>
<th>Ch4 ave</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.495 V</td>
<td>3.415 V</td>
<td>5.815 V</td>
<td>0.905 V</td>
</tr>
</tbody>
</table>

11 Wed Jun 2014
K (Vps) = 15%
K(Vp) = 21%
5.8 x 0.15 (Vps) = 0.87 Volts
2.5 x 0.21 (Vp) = 0.53 Volts
0.87 V + 0.53 V = 1.4 Volts
But Vcc max measured = 0.91 Volts
Vps affecting Vp

Vps Impact on Vp – 43 %
Thus Vps of 5.8 V impacts Vp by 2.5 V

2.5 V x 21% = 0.53

1.5 V – 0.53V = 0.97 V
After Connector Fixed
From the Load Box Test

- $R_t = 0.16$ Ohms
- $R_f = 0.88$ Ohms
- $R_p = 0.20$ Ohms
- $K = 21\%$
- $\Delta CR = 80\%$
From V-Drop Test

0.35 Volts

0.07 Volts

0.26 Volts

K(V_{ps}) = 21%
Overnight Recording #2, Zoom-In On Time Of Highest Steady State Cow Contact Voltage.

- Vpri_n - ref
- Vsec_n - ref
- Vpri - sec
- Vcc

Volts
- Ch1 ave: 1.240 V
- Ch2 ave: 1.315 V
- Ch3 ave: 0.125 V
- Ch4 ave: 0.270 V

13 Fri Jun 2014

06/13/14 08:09:39
K (Vps) = 26%
K(Vp) = 21%
0.13 x 0.26 (Vps) = 0.03 Volts
1.24 x 0.21 (Vp) = 0.26 Volts
0.03 V + 0.26 V = 0.29 Volts
Vcc max measured = 0.27 Volts
Example #2
From the Load Box Test

- $R_t = 0.28$ Ohms
- $R_f = 1.68$ Ohms
- $R_p = 0.32$ Ohms
- $K = 38\%$
- $\Delta CR = 85\%$
From V-Drop Test

0.6 Volts

0.03 Volts

0.60 Volts

13.5 A

0.32 Volts

R(source)

R(g barn)

R(cow) - 510 Ohms

V(p)

R(g xfrm)

R(p pole)

R(d main)

R(pri)

R(sd barn)
K (Vps) = 53 %
K(Vp) = 38%
0.53 \times 0.89 \ (Vps) = 0.47 \ \text{Volts}
0.38 \times 1.695 \ (Vp) = 0.64 \ \text{Volts}
0.47 \text{ V} + 0.64 \text{ V} = 1.11 \ \text{Volts}
Vcc \ \text{max measured} = 1.22 \ \text{Volts}
From the Voltage Drop Test, almost all of the voltage drop between the transformer and the barn shows up as barn panel to reference rod voltage.
From the voltage drop test, a 13.5 Amp load generated a change of 0.32 Volts in the cow contact voltage. Thus a 0.89 Volt drop should generate a Vcc change of $\frac{0.89}{0.6} \times 0.32 = 0.47$ Volts
• $0.38 \times 2.57 \text{ Volts (Vs)} = 0.98 \text{ Volts}$

• $Vps = 0.89 \text{ Volts}$

• $100\% \text{ of } 0.89 \text{ Volts} = 0.89 \text{ Volts}$

• $0.05\% \text{ of } 0.89 \text{ Volts} = 0.04 \text{ Volts}$

• Adjusted $Vs$ without Voltage drop $= 1.69 \text{ Volts}$.  

• Adjusted $Vp$ without Voltage drop $= 1.69 \text{ Volts}$.

• Contribution from $Vp = 1.69 \times 0.38 = 0.64 \text{ Volts}$

• From $Vps$, $0.89 \times 38\% = 0.34 \text{ Volts}$

• $0.34 + 0.64 = 0.98 \text{ Volts}$.  

• $0.47 + 0.64 = 1.11 \text{ Volts}$
Example #3
Overnight Test
Zoom-In On Time of Highest Steady State Cow Contact Voltage

04/24/13 05:05:48
VOLTAGE
Ch1 ave: 0.410 V
Ch2 ave: 0.705 V
Ch3 ave: 0.835 V
Ch4 ave: 0.535 V
From the Load Box Test

- $R_t = 0.12 \text{ Ohms}$
- $R_f = 6.82 \text{ Ohms}$
- $R_p = 0.13 \text{ Ohms}$
- $K = 51 \%$
- $\Delta CR = 98\%$
From V-Drop Test

0.90 Volts

0.76 Volts

0.27 Volts

0.15 Volts

0.76 Volts

12.7 A
K (Vps) = 30 %
K(Vp) = 51%
0.30 x 0.84 (Vps) = 0.25 Volts
0.51 x 0.41 (Vp) = 0.21 Volts
0.25 V + 0.21 V = 0.46 Volts
Vcc max measured = 0.54 Volts
From the Voltage Drop Test, 85 % of the voltage drop between the transformer and the barn shows up as barn panel to reference rod voltage. And thus 15 % shows up at as a change in Vp.
From the voltage drop test, a 12.7 Amp load generated a Vdrop of 0.9 Volts and a change of 0.27 Volts in the cow contact voltage. Thus a 0.89 Volt drop should generate a Vcc change of about the same in the overnight recording.
• 0.51 (k factor) x 0.7 Volts (Vs) = 0.36 Volts
• Vps = 0.89 Volts
• 85 % of 0.89 Volts = 0.76 Volts
• 0.15 % of 0.89 Volts = 0.13 Volts
• Adjusted Vs without Voltage drop = Volts.
• Adjusted Vp without Voltage drop = Volts.
• Contribution from Vp = 0.41 X 0.51 = 0.21 Volts
• From Vps, 0.71 x 51 % = 0.36 Volts
Example # 4
From the Load Box Test

- $R_t = 0.18$ Ohms
- $R_f = 2.25$ Ohms
- $R_p = 0.22$ Ohms
- $K = 41\%$
- $\Delta CR = 82\%$
From V-Drop Test

0.76 Volts

12.9 A

0.32 Volts

0.06 Volts

0.67 Volts
K(Vps) = 42 %
K(Vp) = 41%
1.395 x 0.42 (Vps) = 0.59 Volts
0.22 x 0.41 (Vp) = 0.09 Volts
0.7 V + 0.11 V = 0.68 Volts
Vcc max measured = 0.79 Volts
Example # 4A
Overnight Test
Zoom In On Time Of Highest Steady State Goat Contact Voltage

VOLTAGE
Ch1 ave: 0.395 V
Ch2 ave: 1.120 V
Ch3 ave: 0.740 V
Ch4 ave: 0.585 V

11/03/14 13:03:47

3 Mon Nov 2014
From the Load Box Test

• $R_t = 0.27$ Ohms

• $R_f = 7.2$ Ohms

• $R_p = 0.28$ Ohms

• $K = 48\%$

• $\Delta CR = 98\%$
From V-Drop Test

- 0.34 Volts
- 0.01 Volts
- 0.17 Volts
- 0.35 Volts

13.4 A

V(p)
K (Vps) = 50 %
K(Vp) = 48%
0.74 x 0.5 (Vps) = 0.37 Volts
0.395 x 0.48 (Vp) = 0.19 Volts
0.37 V + 0.19 V = 0.56 Volts
Vcc max measured = 0.585 Volts
Example # 5
Overnight Recording, Zoom-In On Time Of Highest Steady State Cow Contact Voltage.

Voltages:
- Ch1 ave: 0.585 V
- Ch2 ave: 1.130 V
- Ch3 ave: 1.000 V
- Ch4 ave: 0.560 V

07/15/14 17:01:15

15 Tue Jul 2014
From the Load Box Test

- $R_t = 0.15 \text{ Ohms}$
- $R_f = 1.5 \text{ Ohms}$
- $R_p = 0.16 \text{ Ohms}$
- $K = 30\%$
- $\Delta CR = 91\%$
From V-Drop Test

1.53 Volts

12.95 A

0.40 Volts

0.3 Volts

1.3 Volts

R(pri) R(sd main) R(sd barn) R(source) R(g franc) R(g pole) R(g barn) R(eow) - 510 Ohms
K (Vps) = 26 %
K(Vp) = 30%
1.66 x 0.26 (Vps) = 0.43 Volts
0.57 x 0.30 (Vp) = 0.17 Volts
0.61 V + 0.17 V = 0.60 Volts
Vcc max measured = 0.56 Volts
Example # 6
Load Box Test,

- Vp necessary to cause vcc of 0.515 Volts.
- Vp necessary to cause vcc of 0.5 Volts.
- Vp(max) as recorded over night.

- Vcc (max) from overnight recording.
- Vcc caused by Vp(max).

Point (0.515, 1.46)
From the Load Box Test

- $R_t = 0.23 \text{ Ohms}$
- $R_f = 1.12 \text{ Ohms}$
- $R_p = 0.27 \text{ Ohms}$
- $K = 18 \%$
- $\Delta CR = 83\%$
From V-Drop Test

0.32 Volts

13.7 A

0.06 Volts

0.06 Volts

0.17 Volts

R(pri) R(sd main) R(sd barn) R(source) R(g barn) R(g pmle) R(g cnr)

V(p)
K (Vps) = 30 %
K(Vp) = 18%
0.055 x 0.30 (Vps) = 0.02 Volts
1.46 x 0.18 (Vp) = 0.26 Volts
0.26 V + 0.02 V = 0.28 Volts
Vcc max measured = 0.515 Volts
On Farm Source, Not Vps
Example # 7
Overnight Recording #1, Steady State Voltages.
Overnight Recording #1, Zoom-In On Time Of Highest Steady State Cow Contact Voltage.
From the Load Box Test

- $R_t = 0.18$ Ohms
- $R_f = 0.97$ Ohms
- $R_p = 0.25$ Ohms
- $K = 21\%$
- $\Delta CR = 90\%$
From V-Drop Test

3.75 Volts

1.62 Volts

2.16 Volts

11.5 A

0.56 Volts

R(pri)

R(sd main)

R(sd barn)

R(source)

V(p)

R(g pri)

R(g main)

R(g pole)

R(g barn)

R(cow) - 510 Ohms
K (Vps) = 15%
K(Vp) = 21%
5.8 x 0.15 (Vps) = 0.87 Volts
2.5 x 0.21 (Vp) = 0.53 Volts
0.87 V + 0.53 V = 1.4 Volts
But Vcc max measured = 0.91 Volts
Vps affecting Vp

Vps Impact on Vp – 43 %
Thus Vps of 5.8 V impacts Vp by 2.5 V

\[2.5 \text{ V} \times 21\% = 0.53\]
\[1.5 \text{ V} - 0.53\text{V} = 0.97 \text{ V}\]
After Connector Fixed
Overnight Recording #2, Zoom-In On Time Of Highest Steady State Cow Contact Voltage.

- Vpri n - ref
- Vsec n - ref
- Vpri - sec
- Vcc

Volts
Ch1 ave: 1.240 V
Ch2 ave: 1.315 V
Ch3 ave: 0.125 V
Ch4 ave: 0.270 V

06/13/14 08:09:39
13 Fri Jun 2014
From the Load Box Test

- $R_t = 0.16$ Ohms
- $R_f = 0.88$ Ohms
- $R_p = 0.20$ Ohms
- $K = 21\%$
- $\Delta CR = 80\%$
From V-Drop Test

0.35 Volts

0.07 Volts

12.6 A

0.09 Volts

0.26 Volts

R(pri)

R(sd main)

R(g effu)

R(g pole)

R(sd barn)

R(g barn)

R(source)

R(cow) - 510 Ohms
\[ K \text{ (Vps)} = 26\% \]
\[ K\text{(Vp)} = 21\% \]
\[ 0.13 \times 0.26 \text{ (Vps)} = 0.03 \text{ Volts} \]
\[ 1.24 \times 0.21 \text{ (Vp)} = 0.26 \text{ Volts} \]
\[ 0.03 \text{ V} + 0.26 \text{ V} = 0.29 \text{ Volts} \]
\[ V_{cc \text{ max measured}} = 0.27 \text{ Volts} \]
Example #1
From the Load Box Test

- $R_t = 0.03$ Ohms
- $R_f = 0.2$ Ohms
- $R_p = 0.05$ Ohms
- $K = 73\%$
- $\Delta CR = 82\%$
From V-Drop Test

0.23 Volts

13 Amps

0.135 Volts

R(pri) R(sd main)

R(g pole) R(g xfm)

R(sd barn) R(source)

R(g barn) R(cow) - 510 Ohms

0.05 Volts

0.18 Volts
80% shows up at the barn pnl
20% show up at the primary neutral
K (Vps) = 59 %
K(Vp) = 73%
0.59 x 0.33 (Vps) = 0.19 Volts
0.73 x 0.325 (Vp) = 0.24 Volts
0.19 V + 0.24 V = 0.43 Volts
Vcc max (as measured) = 0.42 Volts
Without the voltage drop, \( V_p \) would be equal to \( V_s \), and \( V_{cc} \) should be \( k \times V_s \) (or \( V_p \)). So what is the contribution of \( V_p \) to the stray voltage levels at the time of highest \( V_{cc} \)?
• 0.73 (k factor) x 0.57 Volts (Vs) = 0.42 Volts
• Vps = 0.33 Volts
• 80 % of 0.33 Volts = .24 Volts
• 20 % of 0.33 Volts = 0.06 Volts
• Adjusted Vs without Voltage drop = 0.33 Volts.
• Adjusted Vp without Voltage drop = 0.27 – 0.33 Volts.
• Contribution from Vp = 0.2 – 0.24 Volts
• Vps x 0.24 x 73 % = 0.18 Volts
• 0.24 + 0.18 = 0.42 Volts.