Z400 H.V Series
EVALUATION DATA

<table>
<thead>
<tr>
<th>APPD</th>
<th>CHK</th>
<th>DWG</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>80r B.</td>
<td>yamiv</td>
</tr>
<tr>
<td>17/12/15</td>
<td>18/12/15</td>
<td>24/11/13</td>
</tr>
</tbody>
</table>

TDK-Lambda
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TERMINOLOGY USED

<table>
<thead>
<tr>
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<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vin</td>
<td>Input voltage</td>
</tr>
<tr>
<td>Vout</td>
<td>Output voltage</td>
</tr>
<tr>
<td>Iin</td>
<td>Input current</td>
</tr>
<tr>
<td>Iout</td>
<td>Output current</td>
</tr>
<tr>
<td>Ta</td>
<td>Ambient temperature</td>
</tr>
<tr>
<td>f</td>
<td>Frequency</td>
</tr>
<tr>
<td>C.V</td>
<td>Constant voltage mode</td>
</tr>
<tr>
<td>C.C</td>
<td>Constant current mode</td>
</tr>
</tbody>
</table>

TDK-Lambda
1. EVALUATION METHOD

1.1 Circuit used for determination

(1) Steady state data

(2) Warm up voltage drift characteristics same as Steady state data

(3) Warm up current drift characteristics same as Steady state data

(4) Over voltage protection (OVP) characteristics

(5) Output voltage rise/fall characteristics same as Steady state data

(6) Output current rise/fall characteristics
1.1 Circuit used for determination

(7) Dynamic line voltage and current response characteristics

(8) Dynamic load voltage and current response characteristics

Constant Voltage mode

Output current waveform
lout 0% ↔ 100%

Output current waveform
lout 50% ↔ 100%
1.1 Circuit used for determination

(9) Response to brown-out characteristics

(10) Inrush current characteristics same as Response to brown-out

(11) Leakage current characteristics

(12) Output Voltage ripple & noise waveform 160V up to 650V models

(a) Normal mode (JEITA Standard RC-9131A)
1.1 Circuit used for determination

(12) Output Voltage ripple & noise waveform 160V up to 650V models

(b) Normal + Common mode

(13) Output Current rms ripple 160V to 650V models

Notes:
(*) Output Current rms ripple = Output Voltage rms ripple divided by the Load resistance.
1.2 List of equipment used

<table>
<thead>
<tr>
<th>EQUIPMENT USED</th>
<th>MANUFACTURER</th>
<th>MODEL No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Digital oscilloscope</td>
<td>YOKOGAWA</td>
<td>DL1740 E/EL</td>
</tr>
<tr>
<td>2 Digital multimeter</td>
<td>AGILENT</td>
<td>34401A</td>
</tr>
<tr>
<td>3 Digital power meter</td>
<td>YOKOGAWA</td>
<td>WT230 / WT110</td>
</tr>
<tr>
<td>4 AC source</td>
<td>CHROMA</td>
<td>6590/6463/6520/6530</td>
</tr>
<tr>
<td>5 Electronic load</td>
<td>H&amp;H</td>
<td>ZS1880/ZS7060/ZS4260</td>
</tr>
<tr>
<td>6 Electronic load</td>
<td>CHROMA</td>
<td>63202 / 63204</td>
</tr>
<tr>
<td>7 Leakage current tester</td>
<td>KIKUSUI</td>
<td>TOS3200</td>
</tr>
<tr>
<td>8 Voltage probe</td>
<td>YOKOGAWA</td>
<td>701939/701944</td>
</tr>
<tr>
<td>9 Current probe</td>
<td>YOKOGAWA</td>
<td>701933</td>
</tr>
<tr>
<td>10 Inrush Current Meter</td>
<td>TAKAMISAWA</td>
<td>PSA-210</td>
</tr>
<tr>
<td>11 Data acquisition / switch unit</td>
<td>AGILENT</td>
<td>34970A</td>
</tr>
<tr>
<td>12 Controlled temp. chamber</td>
<td>THERMOTRON</td>
<td>SM-16-3800</td>
</tr>
<tr>
<td>13 Controlled temp. chamber</td>
<td>THERMOTRON</td>
<td>SM-16-8200</td>
</tr>
<tr>
<td>14 Controlled temp. chamber</td>
<td>THERMOTRON</td>
<td>SE-600-5-5</td>
</tr>
<tr>
<td>15 Controlled temp. chamber</td>
<td>THERMOTRON</td>
<td>SE-600-6-6</td>
</tr>
</tbody>
</table>
2. CHARACTERISTIC

2.1 Steady state data

(1) Regulation - Line & Load, Temperature drift

<table>
<thead>
<tr>
<th>Vin (AC)</th>
<th>85</th>
<th>100</th>
<th>200</th>
<th>285</th>
<th>Line Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>159.9690</td>
<td>159.9690</td>
<td>159.9689</td>
<td>159.9689</td>
<td>0.1</td>
</tr>
<tr>
<td>25%</td>
<td>159.9681</td>
<td>159.9679</td>
<td>159.9681</td>
<td>159.9680</td>
<td>0.2</td>
</tr>
<tr>
<td>50%</td>
<td>159.9677</td>
<td>159.9673</td>
<td>159.9676</td>
<td>159.9674</td>
<td>0.5</td>
</tr>
<tr>
<td>75%</td>
<td>159.9668</td>
<td>159.9665</td>
<td>159.9672</td>
<td>159.9671</td>
<td>0.7</td>
</tr>
<tr>
<td>100%</td>
<td>159.9659</td>
<td>159.9662</td>
<td>159.9664</td>
<td>159.9663</td>
<td>0.5</td>
</tr>
<tr>
<td>R Load</td>
<td>3.1</td>
<td>2.8</td>
<td>2.5</td>
<td>2.8</td>
<td>ΔV(mV) (%)</td>
</tr>
<tr>
<td>Regulation</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>(%)</td>
</tr>
</tbody>
</table>

Conditions: Ta = 25°C

1. Regulation - Line & Load, C.V mode (Readings in [V])

2. Temperature drift, C.V mode

<table>
<thead>
<tr>
<th>Ta</th>
<th>0°C</th>
<th>25°C</th>
<th>50°C</th>
<th>Temp. Coefficient (0°C~50°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vout</td>
<td>159.981</td>
<td>159.948</td>
<td>159.922</td>
<td>59 mV</td>
</tr>
</tbody>
</table>

Conditions: Vin:100Vac
Iout:100%

TDK-Lambda
2.1 Steady state data

(1) Regulation - Line & Load, Temperature drift

Conditions: Ta = 25°C

1. Regulation - Line & Load, C.V mode  (Readings in [V])

<table>
<thead>
<tr>
<th>Io</th>
<th>Vin (AC) 85</th>
<th>100</th>
<th>200</th>
<th>265</th>
<th>Line Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>649.8777</td>
<td>649.8796</td>
<td>649.8809</td>
<td>649.8819</td>
<td>4.2</td>
</tr>
<tr>
<td>25%</td>
<td>649.8968</td>
<td>649.8976</td>
<td>649.8977</td>
<td>649.8986</td>
<td>2.0</td>
</tr>
<tr>
<td>50%</td>
<td>649.8880</td>
<td>649.8886</td>
<td>649.8886</td>
<td>649.8886</td>
<td>0.6</td>
</tr>
<tr>
<td>75%</td>
<td>649.8894</td>
<td>649.8994</td>
<td>649.8995</td>
<td>649.8901</td>
<td>0.7</td>
</tr>
<tr>
<td>100%</td>
<td>649.8901</td>
<td>649.8905</td>
<td>649.8909</td>
<td>649.8904</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Load Regulation: 0.002 0.002 0.002 0.001 (%)

2. Temperature drift, C.V mode

Conditions: Vin: 100Vac
Icout: 100%

<table>
<thead>
<tr>
<th>Ta</th>
<th>0°C</th>
<th>25°C</th>
<th>50°C</th>
<th>Temp. Coefficient (0°C~50°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vout</td>
<td>650.079</td>
<td>649.917</td>
<td>649.792</td>
<td>287 mV</td>
</tr>
</tbody>
</table>
2.1 Steady state data

(1) Regulation - Line & Load, Temperature drift

Conditions: Ta = 25°C

1. Regulation - Line & Load, C.C mode (*) (Readings in [A])

<table>
<thead>
<tr>
<th>Vin (AC)</th>
<th>85</th>
<th>100</th>
<th>200</th>
<th>265</th>
<th>Line Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>2.5596</td>
<td>2.5996</td>
<td>2.5996</td>
<td>2.5996</td>
<td>0.0</td>
</tr>
<tr>
<td>25%</td>
<td>2.5593</td>
<td>2.5993</td>
<td>2.5993</td>
<td>2.5993</td>
<td>0.0</td>
</tr>
<tr>
<td>50%</td>
<td>2.5593</td>
<td>2.5993</td>
<td>2.5992</td>
<td>2.5992</td>
<td>0.1</td>
</tr>
<tr>
<td>75%</td>
<td>2.5590</td>
<td>2.5990</td>
<td>2.5990</td>
<td>2.5990</td>
<td>0.0</td>
</tr>
<tr>
<td>100%</td>
<td>2.5587</td>
<td>2.5988</td>
<td>2.5987</td>
<td>2.5987</td>
<td>0.1</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>0.035</td>
<td>0.031</td>
<td>0.035</td>
<td>0.035</td>
<td>ΔI(mA) (%)</td>
</tr>
</tbody>
</table>

Notes:
(*) Not including load regulation thermal drift effect.

2. Temperature drift, C.C mode

Conditions: Vin:100Vac, Iout:100%

<table>
<thead>
<tr>
<th>Ta</th>
<th>0°C</th>
<th>25°C</th>
<th>50°C</th>
<th>Temp. Coefficient (0°C~50°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iout</td>
<td>2.6030</td>
<td>2.6015</td>
<td>2.6012</td>
<td>1.8 mA</td>
</tr>
</tbody>
</table>

TDK-Lambda
2.1 Steady state data

(1) Regulation - Line & Load, Temperature drift

Conditions: Ta = 25°C

1. Regulation - Line & Load, C.C mode (*) (Readings in [A])

<table>
<thead>
<tr>
<th>Vo</th>
<th>85</th>
<th>100</th>
<th>200</th>
<th>285</th>
<th>Line Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0.6399</td>
<td>0.6399</td>
<td>0.6399</td>
<td>0.6399</td>
<td>0.0</td>
</tr>
<tr>
<td>25%</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.0</td>
</tr>
<tr>
<td>50%</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.0</td>
</tr>
<tr>
<td>75%</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.0</td>
</tr>
<tr>
<td>100%</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.6400</td>
<td>0.6401</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Load Regulation

<table>
<thead>
<tr>
<th>ΔI(mA)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.016</td>
<td>0.018</td>
</tr>
<tr>
<td>0.016</td>
<td>0.031</td>
</tr>
</tbody>
</table>

Notes:
(*) Not including load regulation thermal drift effect.

2. Temperature drift, C.C mode

Conditions: Vin:100Vac
lout:100%

<table>
<thead>
<tr>
<th>Ta</th>
<th>0°C</th>
<th>25°C</th>
<th>50°C</th>
<th>Temp. Coefficient (0°C~50°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lout</td>
<td>0.6399</td>
<td>0.6400</td>
<td>0.6404</td>
<td>0.5 mA</td>
</tr>
</tbody>
</table>
2.1 Steady state data

(2) Output voltage and ripple voltage v.s input voltage

C.V mode

- Conditions: I_{out}:100%  
- Ta:  
  - 0°C  
  - 25°C  
  - 50°C  

![Graph showing output voltage and ripple voltage vs input voltage for C.V mode.]

(3) Output current and ripple current v.s input voltage

C.C mode

- Conditions: V_{out}:100%  
- Ta:  
  - 0°C  
  - 25°C  
  - 50°C  

![Graph showing output current and ripple current vs input voltage for C.C mode.]

TDK-Lambda
2.1 Steady state data

(2) Output voltage and ripple voltage v.s input voltage

C.V mode

Conditions: Iout:100%

Ta:
0°C  
25°C  
50°C  

(3) Output current and ripple current v.s input voltage

C.C mode

Conditions: Vout:100%

Ta:
0°C  
25°C  
50°C  

TDK-Lambda
2.1 Steady state data

(4) Efficiency and Input current vs. Output current

Conditions:

- Vin: 85 VAC
- 100 VAC
- 200 VAC
- 285 VAC
- Vout: 100%
- Ta: 25°C

![Graph](Z160-2.6)

**Efficiency**

**Input current (A)**

**Output current (%)**

TDK-Lambda
2.1 Steady state data

(4) Efficiency and Input current vs. Output current

Conditions:
- Vin: 85 VAC
- 100VAC
- 200 VAC
- 265 VAC
- Vout: 100%
- Ta: 25°C

![Graph showing efficiency and input current vs. output current.](image)
2.2 Warm up drift & stability

C.V mode

Z160-2.6

Output voltage drift vs. time (hrs)

C.C mode

Z160-2.6

Output current drift vs. time (hrs)

Conditions: Vin: 100Vac
Vout: 100%
Iout: 100%
Ta = 25°C

TDK-Lambda

T-14
2.2 Warm up drift & stability

C.V mode

Conditions: Vin: 100V ac
Vout: 100%
lout: 100%
Ta = 25°C

C.C mode
2.3 Over voltage protection (OVP) characteristics

Conditions: Vin: 100 Vac
Iout: 0%
Ta = 25°C

OVP setting: 176V

OVP setting: 717V
2.4 ON/OFF Output rise characteristics

C.V mode

Z160-2.6

Conditions: Vin: 100Vac
             Vout: 100%
             Iout: 0%
             Isat=105%
             Ta = 25°C

Z650-0.64

TDK-Lambda
2.4 ON/OFF Output rise characteristics

C.V mode

Z160-2.6

Conditions: Vin: 100Vac
            Vout: 100%
            Ion: 100%
            Iset=105%
            Load: CR
            Ta = 25°C

Z650-0.64

200\text{\textdegree}I_{\text{DIV}} \quad 50\text{\textdegree}I_{\text{DIV}}
2.4 ON/OFF Output rise characteristics

C.C mode

Z160-2.6

Conditions: Vin:100Vac
Vout: 100%
lout: 100%
Vset=105%
Load: CR
Ta = 25°C

Z650-0.64

0.2A/div
50ms/div
2.4 ON/OFF Output rise characteristics

C.C mode

**Z160-2.6**

Conditions: Vin: 100Vac
Iout: 100%
Vset=105%
shorted ouput
Ta = 25°C

**Z650-0.64**

0.2*I_{DN}  20.ms/I_{DN}

TDK-Lambda

T-20
2.5 ON/OFF Output fall characteristics

C.V mode

Z160-2.6

Z650-0.64

Conditions: Vin: 100Vac
Vout: 100%
lout: 0%
Iset=105%
Ta = 26°C
2.5 ON/OFF Output fall characteristics

C.V mode

**Z160-2.6**

Conditions: Vin: 100Vac
Vout: 100%
lout: 100%
Iset=105%
Load: CR
Ta = 25°C

**Z650-0.64**

TDK-Lambda
2.5 ON/OFF Output fall characteristics

C.C mode

Conditions: Vin: 100Vac
Vout: 100%
lout: 100%
Vsel=105%
Load: CR
Ta = 25°C
2.5 ON/OFF Output fall characteristics

C.C mode

Conditions: Vin: 100Vac
lout: 100%
Vset=105%
shorted output
Ta = 25°C

Z400 H.V

Z160-2.6

Z650-0.64

TDK-Lambda
2.6 Hold up time characteristics

Conditions: Vin: 100 Vac
Vout: 100%
Ta = 25°C

[Graph showing hold up time vs. output current]
2.6 Hold up time characteristics

Conditions: Vin: 100 Vac
Vout: 100%
Ta = 25°C

TDK-Lambda T-26
2.7 Dynamic line response characteristics

C.V mode

Conditions: Vin: 85 → 132V
Vout: 100%
lout: 100%
Ta = 26°C

Conditions: Vin: 170 → 265V
Vout: 100%
lout: 100%
Ta = 25°C
2.7 Dynamic line response characteristics

C.V mode

Conditions: Vin:85→132V
Vout: 100%
lout: 100%
Ta = 25°C

Vout: 50mv/Div
500ms/Div

Conditions: Vin:170→265V
Vout: 100%
lout: 100%
Ta = 25°C

Vout: 50mv/Div
500ms/Div
2.7 Dynamic line response characteristics

C.C mode

Conditions: Vin: 85→132V
Vout: 100%
lout: 100%
Ta = 25°C

Conditions: Vin: 170→265V
Vout: 100%
lout: 100%
Ta = 25°C
2.7 Dynamic line response characteristics

C.C mode

Conditions: Vin:85→132V
Vout: 100%
Iout: 100%
Ta = 25°C

Conditions: Vin:170→265V
Vout: 100%
Iout: 100%
Ta = 25°C
2.8 Dynamic load response characteristics

C.V mode

Conditions:  
Vin: 100 Vac  
Vout: 100%  
Ta = 25°C

Load current:  
tr=tf=100us

![Graphs showing dynamic load response characteristics for different frequencies and currents.]
2.8 Dynamic load response characteristics

C.V mode

Conditions:  
Vin: 100Vac  
Vout: 100%  
Ta = 25°C

<table>
<thead>
<tr>
<th>Output Level</th>
<th>Frequency</th>
<th>1V/div</th>
<th>2ms/div</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% → 100%</td>
<td>100Hz</td>
<td>0.13%</td>
<td>-0.21%</td>
</tr>
<tr>
<td>50% → 100%</td>
<td>100Hz</td>
<td>0.05%</td>
<td>-0.06%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output Level</th>
<th>Frequency</th>
<th>0.5V/div</th>
<th>200ms/div</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% → 100%</td>
<td>1000Hz</td>
<td>0.06%</td>
<td>-0.07%</td>
</tr>
<tr>
<td>50% → 100%</td>
<td>1000Hz</td>
<td>0.05%</td>
<td>-0.05%</td>
</tr>
</tbody>
</table>

TDK-Lambda

T-32
2.8 Dynamic load response characteristics

Conditions: Vin:100Vac
Ta = 26°C

C.C mode

![Graphs showing dynamic load response characteristics for different parts and conditions.]

- **Z160-2.6**
  - Current: Io=2.6A
  - Vout:144→120V
  - Frequency: f=10Hz
  - Delays:
    - 0.5t<sub>tdiv</sub> = 20ms
    - 19.42% = -18.50%

- **Z650-0.64**
  - Current: Io=0.64A
  - Vout:585→487.5V
  - Frequency: f=10Hz
  - Delays:
    - 0.1t<sub>tdiv</sub> = 20ms
    - 20.49% = -17.68%

- **Z400 H.V**
  - Current: Io=1.3A
  - Vout:144→120V
  - Frequency: f=10Hz
  - Delays:
    - 0.2t<sub>tdiv</sub> = 20ms
    - 8.46% = -7.50%

- **Z650-0.32**
  - Current: Io=0.32A
  - Vout:586→487.5V
  - Frequency: f=10Hz
  - Delays:
    - 0.05t<sub>tdiv</sub> = 20ms
    - 9.72% = -8.78%
2.9 Response to brown-out characteristics

C.V mode

Conditions: Vin: 100VAC
Vout: 100%
lout: 100%
Ta = 25°C

Brown-out time
A - 21mS
B - 26mS
C - 69mS
2.9 Response to brown-out characteristics

C.V mode

Conditions: Vin: 100VAC
Vout: 100%
lout: 100%
Ta = 25°C

Brown-out time
A - 15ms
B - 27ms
2.9 Response to brown-out characteristics

C.C mode

Conditions: Vin: 100VAC
Vout: 100%
Iout: 100%
Ta = 25°C

Brown-out time
A - 21mS
B - 26mS
C - 69mS

lout: 1/A_DV  100ns/DIV
2.9 Response to brown-out characteristics

C.C mode

**Conditions:**
- Vin: 100VAC
- Vout: 100%
- Iout: 100%
- Ta = 25°C

**Brown-out time**
- A: 15mS
- B: 28mS
- C: 47mS

**Diagram:**
- Out: 0.2^2/\text{DIV}
- 100^\text{ns}/\text{DIV}
2.10 Inrush Current Characteristics during line brown outs

Conditions: Vin: 100VAC
Vout: 100%
Iout: 0%
Iout: 100%
Ta = 25°C

Max Inrush Current (A)
Brown out time (s)
2.10 Inrush Current Characteristics during line brown outs

Conditions: Vin: 200VAC
Vout: 100%
lout: 0%
lout: 100%
Ta = 25°C

Max Inrush Current (A)

Brown out time [s]
2.11 Inrush current waveform

Conditions: Vin: 100V
    Vout: 100%
    Iout: 100%
    Ta = 25°C

Switch on phase angle of input AC voltage

\( \phi = 0° \)

Switch on phase angle of input AC voltage

\( \phi = 90° \)
2.11 Inrush current waveform

Conditions: Vin: 200V
Vout: 100%
lout: 100%
Ta = 25°C

Switch on phase angle of Input AC voltage
\( \phi = 0^\circ \)

Switch on phase angle of Input AC voltage
\( \phi = 90^\circ \)

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2.11 Inrush current waveform

Switch on phase angle of input AC voltage
\( \phi = 0^\circ \)

Switch on phase angle of input AC voltage
\( \phi = 90^\circ \)

Conditions: Vin: 100V
Vout: 100%
lout: 100%
Ta = 25°C
2.11 Inrush current waveform

Conditions: Vin: 200V
Vout: 100%
Iout: 100%
Ta = 25°C

Switch on phase angle of input AC voltage
\[ \phi = 0^\circ \]

Switch on phase angle of input AC voltage
\[ \phi = 90^\circ \]
2.12 Input current waveform

Conditions: Vin: 100VAC
Vout: 100%
lout: 100%
Ta = 25°C

Conditions: Vin: 200VAC
Vout: 100%
lout: 100%
Ta = 25°C
2.12 Input current waveform

Conditions: Vin: 100VAC
Vout: 100%
Iout: 100%
Ta = 25°C

Conditions: Vin: 200VAC
Vout: 100%
Iout: 100%
Ta = 25°C

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2.13 Leakage current characteristics

Conditions: Vin: 100~265 Vac
Iout: 0%
Iout: 100%
Ta = 25°C
f=50Hz
2.14 Output voltage ripple & noise waveform

C.V mode

**Normal Mode**

*Conditions: Vin: 100VAC*
*Vout: 100%*
*Iout: 100%*
*Ta = 25°C*

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**Z160-2.6**

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**Z650-0.64**

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