Transformers for Switching Power Supplies

Pin terminal type (For single output)
Pin terminal type (For multiple outputs)

SRW series

Type: LQ (Horizontal type)
      20EG (Vertical type)
      24EG (Vertical type)
      26EG (Vertical type)
      28EG (Vertical type)
      34EG (Vertical type)
      EG (Horizontal type)

Issue date: September 2008
Switching Power Supply Transformers
SRW Series

Development Concept

Our newly developed transformers and chokes feature a new core shape using a new core material that is designed for different core usages based on the advantages of each material's characteristics. Our lineup of transformers (small, thin, or inexpensive) allows us to provide the best transformer for your needs. We can also provide different transformer shapes not shown in the catalog, so feel free to contact us.

CONCEPT (OPTIMAL TRANSFORMER AND CHOKE SHAPES)

<table>
<thead>
<tr>
<th>Usage</th>
<th>Features</th>
<th>Core shape</th>
<th>Existing core name</th>
<th>Improvements for minimizing size</th>
<th>New shapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV electronics</td>
<td>Multiple-output type transformers</td>
<td>Wide opening</td>
<td>EE</td>
<td>Made opening portion according to the 1st and 2nd output number (1st and 2nd openings are asymmetric.)</td>
<td>Material PC47</td>
</tr>
<tr>
<td>Inverter electronics</td>
<td></td>
<td></td>
<td>EER</td>
<td></td>
<td>EGG</td>
</tr>
<tr>
<td>Office machines</td>
<td>Low profile transformers</td>
<td>Low profile</td>
<td>EED</td>
<td></td>
<td>LQ</td>
</tr>
<tr>
<td>Flat panel TVs</td>
<td></td>
<td></td>
<td>EPC</td>
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<tr>
<td>Thin power supplies</td>
<td></td>
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<td>EEM</td>
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<td></td>
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<td>EFD</td>
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</table>

• Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

• All specifications are subject to change without notice.
Transformers and Inductors for Power Supplies  Replacement Parts List

We have made a new lineup of replacement parts for products with different shapes that meet our customers’ needs for smaller products. We can also provide different transformer shapes not shown in the catalog, so feel free to contact us.

REPLACEMENT PARTS LIST

<table>
<thead>
<tr>
<th>New transformer</th>
<th>New core¹</th>
<th>Existing core</th>
<th>Bobbin type²</th>
<th>Maximum external size D×W×H (mm)max.</th>
<th>Maximum output power³ (W)max.</th>
<th>Switching frequency fsw(kHz)</th>
<th>Cross-sectional center leg area Acp (mm²)</th>
<th>Bobbin terminal Pin pitch (mm)</th>
<th>Lead space F (mm)</th>
<th>Number of pins</th>
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<td>EGG2017</td>
<td>EE22</td>
<td>I</td>
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<td>12</td>
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<tr>
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<td>EGG2625</td>
<td>EER32</td>
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For multiple outputs (Horizontal type)

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<tr>
<th>New transformer</th>
<th>New core¹</th>
<th>Existing core</th>
<th>Bobbin type²</th>
<th>Maximum external size D×W×H (mm)max.</th>
<th>Maximum output power³ (W)max.</th>
<th>Switching frequency fsw(kHz)</th>
<th>Cross-sectional center leg area Acp (mm²)</th>
<th>Bobbin terminal Pin pitch (mm)</th>
<th>Lead space F (mm)</th>
<th>Number of pins</th>
</tr>
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<tbody>
<tr>
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<td>EGG2430</td>
<td>EER28L</td>
<td>I</td>
<td>31.0×38.0×29.5</td>
<td>69.4</td>
<td></td>
<td></td>
<td>5.0</td>
<td>30.0</td>
<td>12</td>
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<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>4.0</td>
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<td></td>
</tr>
<tr>
<td>SRW2630EG</td>
<td>EGG2630</td>
<td>EER32</td>
<td>I</td>
<td>32.0×40.5×33.0</td>
<td>80.2</td>
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<td>5.0</td>
<td>32.5</td>
<td>12</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>II</td>
<td>32.0×40.5×33.0</td>
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<td>5.0</td>
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<td>12</td>
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<td>SRW2833EG</td>
<td>EGG2833</td>
<td>EER35</td>
<td>I</td>
<td>33.0×43.0×33.5</td>
<td>90.1</td>
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<td>35.0</td>
<td>12</td>
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<td></td>
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<td></td>
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<td>35.0</td>
<td>12</td>
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<td>LQ24</td>
<td>EER28</td>
<td>I</td>
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<td>4.0</td>
<td>22.5</td>
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<td>SRW24LQL</td>
<td>LQ24</td>
<td>EER28L</td>
<td>I</td>
<td>31.0×27.5×22.0</td>
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<td>5.0</td>
<td>30.0</td>
<td>12</td>
</tr>
</tbody>
</table>

¹ Ferrite cores are not sold separately.
² The bobbin is made from phenol with a flame resistance grade of 94V-2 or higher.
³ This maximum output is only an estimate. The output depends on the switching element, switching frequency, transformer temperature, and use conditions.

* All specifications are subject to change without notice.
For Single Output (Horizontal Type) LQ Series

This series uses the new ferrite material, PC47, which has low loss and high-saturation magnetic flux density that prevents thermorunaway.
This material allows for a low profile, single output switching power supply transformer, which means it can be mounted in very narrow spaces.

FEATURES
- The new high B, low loss PC47* material allows for the product to be smaller
- Uses a newly developed LQ core for small switching power supply transformers
- Compatible with small, single output switching power supplies with a maximum output of 45 to 60W
- It is a product conforming to RoHS directive.
  * Compatible material: PC47

APPLICATIONS
- Switching power supplies for office machines
- Multiple use AC to DC adapters and power supplies for chargers

SHAPES AND DIMENSIONS
EXAMPLE: SRW24LQ, SRW24LQL TYPE (BOBBIN TYPE: I)

RECOMMENDED BASE MATERIAL OPENING SIZE

SPECIFICATIONS

<table>
<thead>
<tr>
<th>New transformer</th>
<th>Bobbin type</th>
<th>Maximum external size D x W x H (mm)/max.</th>
<th>Maximum output power (W)/max.</th>
<th>Switching frequency fsw/(kHz)</th>
<th>Cross-sectional center leg area Acp (mm²)</th>
<th>Bobbin terminal(mm)</th>
<th>Number of pins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Pin pitch</td>
<td>Pin Pitch</td>
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<td>31.0 x 27.5 x 22.0</td>
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<td>63.6</td>
<td>4.0</td>
<td>25.5</td>
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<tr>
<td>SRW28LQD</td>
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<td>30.5 x 39.5 x 22.0</td>
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<td>65.7</td>
<td>5.0</td>
<td>30.0</td>
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</tbody>
</table>

• All specifications are subject to change without notice.
For Multiple Outputs (Vertical Type)  20EG Series

This series uses the new ferrite material, PC47, which has low loss and high-saturation magnetic flux density that prevents thermodrun- away.
This transformer is for small, multiple output switching power supplies with a maximum output from 10 to 15W, and has a perfect balance between the core volume and coil share.

FEATURES
• The new high B, low loss PC47 material allows for the product to be smaller
• This transformer uses a newly developed EGG core for small switching power supplies
• Compatible with multiple output switching power supplies with a maximum output of 10 to 50W
• It is a product conforming to RoHS directive.

APPLICATIONS
• Refrigerators, IH-heaters, and air conditioners
• Multiple output power supplies

SHAPES AND DIMENSIONS
EXAMPLE: SRW2017EG TYPE (BOBBIN TYPE: I)

RECOMMENDED BASE MATERIAL OPENING SIZE

SPECIFICATIONS

<table>
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<tr>
<th>New transformer</th>
<th>Bobbin type</th>
<th>Maximum external size D×W×H (mm)max.</th>
<th>Maximum output power (W)/max.</th>
<th>Switching frequency fs(w/kHz)</th>
<th>Cross-sectional center leg area Acp (mm²)</th>
<th>Bobbin terminal(mm)</th>
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<th>Lead space F</th>
<th>Pin ø</th>
<th>1st side</th>
<th>2nd side</th>
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<tr>
<td></td>
<td>III</td>
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• All specifications are subject to change without notice.
For Multiple Outputs (Vertical Type) 24EG Series

This series uses the new ferrite material, PC47, which has low loss and high-saturation magnetic flux density that prevents thermorunaway. This transformer is for small, multiple output switching power supplies with a maximum output from 25 to 60W, and has a perfect balance between the core volume and coil share.

FEATURES

- The new high B, low loss PC47 material allows for the product to be smaller
- This transformer uses a newly developed EGG core for small switching power supplies
- Compatible with multiple output switching power supplies with a maximum output of 25 to 60W
- It is a product conforming to RoHS directive.
  * Compatible material: PC47

APPLICATIONS

- DVDs, DVD-Rs, STBs, and air conditioners
- Multiple output power supplies

SHAPES AND DIMENSIONS

EXAMPLE: SRW24○○EG TYPE(BOBBIN TYPE: I)

RECOMMENDED BASE MATERIAL OPENING SIZE

SPECIFICATIONS

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<th>New transformer</th>
<th>Bobbin type</th>
<th>Maximum external size D×W×H (mm)max.</th>
<th>Maximum output power (W)max.</th>
<th>Switching frequency fsw(kHz)</th>
<th>Cross-sectional center leg area Acp (mm²)</th>
<th>Bobbin terminal(mm)</th>
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</table>

- All specifications are subject to change without notice.
For Multiple Outputs (Vertical Type) 26EG Series

This series uses the new ferrite material, PC47, which has low loss and high-saturation magnetic flux density that prevents thermorunaway. This transformer is for small, multiple output switching power supplies with a maximum output from 75 to 80W, and has a perfect balance between the core volume and coil share.

FEATURES

- The new high B, low loss PC47* material allows for the product to be smaller
- This transformer uses a new EGG core model developed for power supply transformers
- Compatible with multiple output switching power supplies with a maximum output of 75 to 80W
- It is a product conforming to RoHS directive.
  * Compatible material: PC47

APPLICATIONS

- DVDs, DVD-Rs, STBs, and air conditioners
- Multiple output power supplies

SHAPES AND DIMENSIONS

EXAMPLE: SRW26[○]EG TYPE(BOBBIN TYPE: I)

RECOMMENDED BASE MATERIAL OPENING SIZE

SPECIFICATIONS

<table>
<thead>
<tr>
<th>New transformer</th>
<th>Bobbin type</th>
<th>Maximum external size D×W×H (mm)max.</th>
<th>Maximum output power (W)max.</th>
<th>Switching frequency fsw(kHz)</th>
<th>Cross-sectional center leg area Acp (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRW2625EG</td>
<td>I</td>
<td>35.0×31.0×33.0</td>
<td>75</td>
<td>40</td>
<td>80.2</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>30.0×30.0×33.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRW2630EG</td>
<td>I</td>
<td>35.0×31.0×38.0</td>
<td>80</td>
<td>40</td>
<td>80.2</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>30.0×30.0×38.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- All specifications are subject to change without notice.
For Multiple Outputs (Vertical Type) 28EG Series

This series uses the new ferrite material, PC47, which has low loss and high-saturation magnetic flux density that prevents thermorunaway.

This transformer is for small, multiple output switching power supplies with a maximum output from 90 to 100W, and has a perfect balance between the core volume and coil share.

FEATURES

- The new high B, low loss PC47 material allows for the product to be smaller
- This transformer uses a new EGG core model developed for power supply transformers
- Compatible with small, multiple output switching power supplies with a maximum output of 90 to 100W
- It is a product conforming to RoHS directive.

APPLICATIONS

- DVD-Rs, STBs, and LCDs
- Multiple output power supplies

SHAPES AND DIMENSIONS

EXAMPLE: SRW28 Eclipse Type (BOBBIN TYPE: I)

RECOMMENDED BASE MATERIAL OPENING SIZE

SPECSIFICATIONS

| New transformer | Bobbin type | Maximum external size D×W×H (mm)max. | Maximum output power (W)max. | Switching frequency fsw(kHz) | Cross-sectional center leg area Acp (mm²) | Bobbin terminal(mm) Pin pitch Lead space F F1 F2 Pin ø | Number of pins 1st side 2nd side |
|-----------------|-------------|--------------------------------------|-----------------------------|--------------------------------|----------------------------------------|--------------------------------|------------------|------------------|
| SRW2826EG      | I           | 35.0×32.0×33.0                        | 90                          | 40                             | 90.1                                   | P:5.0 S:5.0 22.5 27.5 0.8 6 11            |                  |                  |
|                 | II          | 32.0×32.0×33.0                        |                             |                                |                                        | 5.0 22.5 1.0 6 6                        |                  |                  |
| SRW2833EG      | I           | 35.0×32.0×40.0                        | 100                         | 40                             | 90.1                                   | P:5.0 S:5.0 22.5 27.5 0.8 6 11            |                  |                  |
|                 | II          | 32.0×32.0×40.0                        |                             |                                |                                        | 5.0 22.5 1.0 6 6                        |                  |                  |
|                 | III         | 32.0×40.0×40.0                        |                             |                                |                                        | 4.0 22.5 0.8 8 10                       |                  |                  |

• All specifications are subject to change without notice.
For Multiple Outputs (Vertical Type) 34EG Series

This series uses the new ferrite material, PC47, which has low loss and high-saturation magnetic flux density that prevents thermorunaway.

This transformer is for small, multiple output switching power supplies with a maximum output from 100 to 120W, and has a perfect balance between the core volume and coil share.

FEATURES
- The new high B, low loss PC47 material allows for the product to be smaller
- This transformer uses a new EGG core model developed for power supply transformers
- Compatible with small, multiple output switching power supplies with a maximum output of 100 to 120W
- It is a product conforming to RoHS directive.
  * Compatible material: PC47

APPLICATIONS
- DVD-Rs, STBs, and LCDs
- Multiple output power supplies

SHAPES AND DIMENSIONS
EXAMPLE: SRW3400EG TYPE (BOBBIN TYPE: I)

RECOMMENDED BASE MATERIAL OPENING SIZE

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Bobbin</th>
<th>Maximum external size D×W×H (mm)max.</th>
<th>Maximum output power (W)max.</th>
<th>Switching frequency fsw(kHz)</th>
<th>Cross-sectional center leg area Acp (mm²)</th>
<th>Bobbin terminal(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bobbin type</td>
<td>p</td>
<td>Pin pitch P</td>
<td>Lead space P</td>
<td>Pin φ</td>
<td>J 1st side</td>
</tr>
<tr>
<td>SRW3435EG I</td>
<td>38.0×38.0×40.0</td>
<td>120</td>
<td>40</td>
<td>146</td>
<td>P: 5.0</td>
</tr>
</tbody>
</table>
For Multiple Outputs (Horizontal Type)  EG Series

This series uses the new ferrite material, PC47, which has low loss and high-saturation magnetic flux density that prevents thermorunaway. This transformer is for small, multiple output switching power supplies with a maximum output from 60 to 100W, and has a perfect balance between the core volume and coil share.

FEATURES

- The new high B, low loss PC47 material allows for the product to be smaller
- This transformer uses a new EGG core model developed for small power supply transformers
- Compatible with small, multiple output switching power supplies with a maximum output of 60 to 100W
- It is a product conforming to RoHS directive.

APPLICATIONS

- DVD-Rs, STBs, and LCDs
- Multiple output power supplies

SHAPES AND DIMENSIONS

EXAMPLE: SRW○○○○EG-H TYPE(BOBBIN TYPE: IIh)

RECOMMENDED BASE MATERIAL OPENING SIZE

SPECIFICATIONS

<table>
<thead>
<tr>
<th>New transformer</th>
<th>Bobbin type</th>
<th>Maximum external size (\text{D} \times \text{W} \times \text{H}) (mm)max.</th>
<th>Maximum output power (\text{W})max.</th>
<th>Switching frequency (\text{fsw}) (kHz)</th>
<th>Cross-sectional center leg area (\text{Acp}) (mm²)</th>
<th>Bobbin terminal (mm)</th>
<th>Number of pins</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRW2430EG</td>
<td>IIH</td>
<td>38.0 × 31.0 × 29.5</td>
<td>60</td>
<td>40</td>
<td>69.4</td>
<td>5.0</td>
<td>6 6</td>
</tr>
<tr>
<td>SRW2630EG</td>
<td>III</td>
<td>31.0 × 38.0 × 25.0</td>
<td>80</td>
<td>40</td>
<td>80.2</td>
<td>5.0</td>
<td>32.5 6 6</td>
</tr>
<tr>
<td>SRW2833EG</td>
<td>III</td>
<td>40.6 × 32.0 × 33.0</td>
<td>100</td>
<td>40</td>
<td>90.1</td>
<td>5.0</td>
<td>35.0 6 6</td>
</tr>
</tbody>
</table>

- All specifications are subject to change without notice.
Transformer Inductors for Power Supplies  Standard GAP

In order to respond to our customers’ requested delivery dates and costs, TDK can provide standard GAP products (indicated by "✓" in the below chart) for each shape. Please contact us about other GAP products separately.

### STANDARD Al-Value

<table>
<thead>
<tr>
<th>Core shape and size</th>
<th>Al-value (nH/²N²)</th>
<th>R10 Series</th>
<th>R20 Series</th>
<th>R40 Series and other specialty products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>160</td>
<td>200</td>
<td>250 315 400 500</td>
</tr>
<tr>
<td>R10 Series</td>
<td></td>
<td>160</td>
<td>180 200 224</td>
<td>250 280 315 400 450 500</td>
</tr>
<tr>
<td>R20 Series</td>
<td></td>
<td>160 180</td>
<td>200 224</td>
<td>250 280 315 400 450 500 525 550</td>
</tr>
</tbody>
</table>

For single output (Vertical/Horizontal)
- SRW24LQ ✓ ✓ ✓ ✓
- SRW24LQL ✓ ✓ ✓ ✓
- SRW28LQD ✓ ✓

### Core shape and size

<table>
<thead>
<tr>
<th>Al-value (nH/²N²)</th>
<th>R10 Series</th>
<th>R20 Series</th>
<th>R40 Series and other specialty products</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>125</td>
<td>160 200</td>
<td>250 315 400 500</td>
</tr>
<tr>
<td>100 112 125 140 160 180 200 224 250 280 315 400</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For multiple outputs (Vertical/Horizontal)
- SRW2017EG ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
- SRW2420EG ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
- SRW2425EG ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
- SRW2430EG ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
- SRW2625EG ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
- SRW2630EG ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
- SRW2826EG ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
- SRW2833EG ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
- SRW3435EG ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓

• All specifications are subject to change without notice.
## Specifications

### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Item</th>
<th>Standard test conditions</th>
<th>Test methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inductance</td>
<td>Individual specification (tolerance±10%)</td>
<td>Use LCR meter (f=1kHz), YHP4261 or equivalent.</td>
</tr>
<tr>
<td>DC resistance</td>
<td>Less than 0.05Ω: +30% max. 0.05 to 0.1Ω: +20% max. 0.1 to 0.5Ω: +15% max. 0.5Ω or more: +10% max.</td>
<td>Use Milliohm-meter VP2941 or equivalent.</td>
</tr>
<tr>
<td>Turn ratio and polarity</td>
<td>Specified value ±1 to 20%, individual specification</td>
<td>Use turn ratio tester TRD-0.9 (f=1 to 100kHz) or equivalent.</td>
</tr>
<tr>
<td>withstand voltage</td>
<td>No abnormality between the primary and secondary windings, between the primary winding and the core, and so on.</td>
<td>Apply separately specified AC voltage (50Hz) for 1min.</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>10MΩ min.</td>
<td>Measure by applying DC.500V. Use insulation resistance meter SM-5E or equivalent.</td>
</tr>
<tr>
<td>Terminal strength</td>
<td>9.8N min.</td>
<td>Apply 9.8N load in the direction of terminal axis for 30±5s. Any terminal must not be pulled out or chatter.</td>
</tr>
<tr>
<td>Temperature rise</td>
<td>Standard design value 45°C max. (thermocouple method) 55°C max. (resistance method)</td>
<td>Measure the core surface by thermocouple method, and the windings by resistance method or thermocouple method.</td>
</tr>
<tr>
<td>Solderability</td>
<td>Solder covers more than 90%.</td>
<td>Dip in solder with the temperature of 245±2°C for 3±0.5s.</td>
</tr>
</tbody>
</table>

### RELIABILITY TESTS

<table>
<thead>
<tr>
<th>Item</th>
<th>Standards</th>
<th>Test methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration resistance</td>
<td>Conform to JIS-C 5025. Sweep 1.5mm amplitude and 10-to-50-to-10Hz in 1min in X, Y, and Z directions for 2h respectively.</td>
<td>Measure in normal temperature after leaving in 100±2°C for 96h.</td>
</tr>
<tr>
<td>Heat resistance</td>
<td>Standard of inductance, insulation resistance, withstand voltage must be satisfied.</td>
<td>Measure in normal temperature after leaving in −40±2°C for 96h.</td>
</tr>
<tr>
<td>Cold resistance</td>
<td></td>
<td>Measure in normal temperature after leaving in 80±2°C and 90 to 95%(RH) for 96h.</td>
</tr>
<tr>
<td>Humidity resistance</td>
<td></td>
<td>One cycle is −25°C for 30min, normal temperature for 30min, and 85°C for 30min; measure after 10 cycles of the test have been performed.</td>
</tr>
<tr>
<td>Temperature cycle</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

• The above listed items are representative examples.
  The details can be found by referring to the appended individual delivery specifications.

### GENERAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>General characteristics</th>
<th>Standard test conditions</th>
<th>Ambiance temperature range</th>
<th>Relative humidity range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature ranges</td>
<td>Operating −10 to +60°C</td>
<td>+5 to +35°C</td>
<td>45 to 85%(RH)[without dewing]</td>
</tr>
<tr>
<td>Humidity ranges</td>
<td>Storage −25 to +85°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating 30 to 95%(RH)[without dewing]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Storage 30 to 95%(RH)[without dewing]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Design reference for switching power transformers

- **Maximum allowable Temperature**
The maximum allowable Temperature of SRW series transformer is classified in E class (120°C) in Japan. However, due to the fact that there is no classification known as E class in North America, it is classified in class 105 (105°C).

- **Temperature rise in Transformers**
In normal design condition, 55°C or less (using the resistance method) is the target of temperature rise of windings. Therefore, the maximum ambient temperature in maximum temperature rise is 65°C in Japan and 50°C for products targeted for North America. In case of measuring the temperature of the windings by thermocouple, 10 to 15°C more would be allowable.

- **Concerning of the influence of leakage flux**
Due to the fact that there is always some degree of leakage flux from transformer, designs should be made to keep them apart as much as possible from parts that are easily affected by this.

- **Magnetic saturation of the core**
  1. Magnetic operating condition of the core in the transformer are determined by maximum operation temperature (including temperature rise) and driving condition in circuits. If product is used in condition that exceed these conditions, there is a possibility of occurring magnetic saturation of the core. The following items could be possible cause of core saturation.
     - The product is used in conditions that exceed the maximum operating temperature.
     - Operating frequencies are lower than the ones initially designed. (longer ON time)
     - The input voltage is abnormally higher than the specified values.

  2. To check on the saturation of the core it is possible to judge from current waveforms of primary winding. Current flowing in the inductor changes in a straight line in relation to time as in the figure a) in accordance with

     \[ I = \frac{E}{L} \times T \]

     However, in the event that a saturation phenomena has occurred in the core, inductance is reduced causing a rapid and drastic increase of current as shown figure b).

(3)In this case, there is possibility that a breakdown may occur due to surpassing the rated current of the switch it is necessary to have over current protection circuit or modify transformer design.

- **Dealing with safety regulation**
Designs are made in consideration of materials, structures and so on that the designed transformers are comply with designated safety regulations.

  1. Regarding the core
     - Dentori, UL/CSA: Designed with reinforced insulation. (Depending upon the shape, Basic insulation may be applied)
     - IEC65, IEC950: To be handled in the same manner as Basic Insulation.

  2. Distance between Transformer and other parts
     Please keep the distance between the transformer and other parts in accordance with applicable safety standards.

- **Damp proofing treatment**
In order to protect the transformer against humidity as well as securing of the core and bobbin, varnish impregnation is used as standard design.

- **Circuit topologies of switching power supply**
The term “topology” refers to the arrangement of the power components within the switching power supply design. There are several different kind of circuit topologies as following;

  - **Forward mode**
     - Buck converter
     - Forward converter
     - Push-Pull converter
     - Half and Full-Bridge converter

  - **Flyback mode**
     - Boost converter
     - Buck-boost converter
     - Flyback converter

---

- All specifications are subject to change without notice.
Which topology of switching power supply to use?
Each topology has its relative merit in terms of cost and performance. One topology may have a low parts cost but only be able to provide a limited amount of power; another may have ample power capability but cost more, and so on.
The following relationship between output voltage and power gives us one suggestion when we need to chose topology in given conditions;

The deference of power conversion between Forward and Flyback mode.
Since the forward mode converter is a system that performs power transmission to the output side during ON period of switching transistor, it is possible to work with the large output current. Consequently, forward converter method is suitable to large current output with relatively lower output voltage.
To the contrary, Flyback mode converter is a system that input power is stored within the Inductor or primary coil in the transformer as a magnetic energy during ON period of switching transistor and the stored energy transmit to output side during OFF period of switching transistor. Accordingly, Flyback mode converter is suitable to high voltage and low current output, and does not suite to large current output.

The stored energy within the inductor.

\[
E = \frac{1}{2} L_p I_p^2 + V_0
\]

and thus the power is the energy per unit time, resulting in

\[
P = \frac{1}{2} L_p I_p^2 f [W]
\]

Where,
- \( L_p \): Inductance of primary winding
- \( I_p \): Peak value of primary current
- \( f \): Switching frequency

How to decide primary inductance (Lp) in Flyback converter.
Using the formula \( P = \frac{1}{2} L_p I_p^2 f [W] \), it is possible to calculate the inductance value needed for the desired output P under the fixed Ip value.
By deriving \( E \times T = L_p \times \frac{dI}{dt} \), the current which flows through the inductor becomes

\[
i = \frac{E \times T}{L_p}
\]

By substituting this with \( P = \ldots \), the formula of \( L_p = \frac{E \times T^2}{2P} \) results.
From this, the formula \( L_p = \frac{E \times T^2}{2P} \) results.

Where,
- \( E \): Input voltage
- \( T \): On time
- \( F \): Switching frequency

In actual designs this value is to be slightly lowered in consideration of the transformer’s efficiency.

How to decide number of turns of primary winding
(1) Flyback converter

\[
N_p = \frac{E_{in} \times T_{max}}{\Delta B \times A}
\]

Where,
- \( E_{in} \): Lower limit value of input voltage [Vdc]
- \( A \): Core cross section area [m²]
- \( D \): Duty ratio
- \( T_{max} \): The maximum ON time for switching transistor [sec.]
- \( \Delta B \): Operating flux density [T]

Precautions must be taken as the upper limit value of \( \Delta B \) changes according to core materials, operating temperatures, frequencies, etc.

(2) Forward converter

The calculation formula of primary winding \( N_p \) is same as in case (1). However, in accordance with separate excitation, the ON time (Tmax.) should be lower than 45% of switching period. Further, it is necessary to consider the residual magnetic flux density of the core, \( \Delta B \) should be slightly lower than that with the flyback converter.

All specifications are subject to change without notice.
• Determining of secondary winding

(1) Flyback converter

As it is necessary to consider the voltage drop of the rectifier diode on the secondary side,

\[ N_S = N_P \times \frac{V_o + V_f}{E_{\text{min.}}} \times \frac{1 - D}{D} \]

Where,

\( V_f \): Voltage drop of the rectifier diode

(2) Forward converter

Output filter inductor must be used at secondary side in the forward converter, the voltage drop of the inductor also need to be considered, resulting,

\[ N_S = N_P \times \frac{(V_o + V_f + V_L) \times 1/D}{E_{\text{min.}}} \]

Where,

\( V_L \): Voltage drop of the Output filter inductor

---

• Example of drive waveforms

Ringing choke system circuit (RCC)

1-transistor forward type converter
In order for designing the transformer, the following conditions are necessary.

It is greatly appreciated if customer can provide us with the required information by filling out the Transformer specifications / inquiry form.

(1) Circuit topology
   - Flyback type, forward type, push-pull, half-bridge, etc
(2) Input voltage range
   - The lower limit of rectified voltage is important, in particular.
(3) Operating frequency
   - It is especially necessary to determine the lower limit frequency for the maximum load condition in Flyback converter.
(4) Maximum duty ratio
   - It is necessary to specify maximum ON time when input voltage is lower limit, approximately 45% should be the maximum for external excitation system.
(5) Maximum temperature rise
   - This is the allowable temperature rise in the transformer, should be equal to the value that ambient temperature has been taken from the temperature index of the materials which is 120°C (105°C in UL system).
(6) Required safety regulations
   - Structures and materials are chosen to comply with required safety regulations.
(7) Output voltage/current
   - Required for determination of the winding ratios and wire gage.
(8) Instructions concerning circuit designs and pin configuration of transformer
   - Type of the secondary rectifier diode is important in particular because of voltage drop between Full recovery and Schottky barrier type is different, it will affect to design of number of turns of transformer.

All specifications are subject to change without notice.
Transformer for Switching Regulator Specification Request Form

1. Company name

Address

2. Department, applicant’s name

Name: ____________________________ E-mail: ____________________________

TEL: ____________________________ FAX: ____________________________

3. Circuit system

Prototype No: ____________________________

4. Input specifications

AC input voltage: Rated ________ (V) to ________ (V) Operating range: ________ (V) to ________ (V)

DC input voltage: Rated ________ (V) to ________ (V) Operating range: ________ (V) to ________ (V)

5. Output specifications

Output voltage/Current/Diode used (diode voltage drop)

<table>
<thead>
<tr>
<th>Output specification</th>
<th>Example</th>
<th>Output1</th>
<th>Output2</th>
<th>Output3</th>
<th>Output4</th>
<th>Output5</th>
<th>Output6</th>
<th>Output7</th>
<th>VCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power application</td>
<td>Motor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output voltage (V)</td>
<td></td>
<td>50V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Accuracy)</td>
<td></td>
<td>(±5V)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Minimum</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical ΔT measuring condition</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum time</td>
<td></td>
<td>1A, 10sec.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak time</td>
<td></td>
<td>2A, 3sec.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary/Secondary</td>
<td>Secondary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Feedback</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rectifier diode</td>
<td>FRD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>VF(V)</td>
<td>0.1</td>
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Rectifier diode: F.R.D: First Recovery Diode, S.B.D: Schottky Barrier Diode

6. Pin assignments changes

Possible    Impossible

7. Clock frequency

Flexible (fixed)  to  (kHz)

8. Input capacitor capacitance

CIN: ________ (µF)

9. Operating temperature range, max. temperature rise, and ambient temperature

Primary - secondary: ________ to ________ (°C) ΔT ________ (°C Typ. Max.): Ambient temperature ________ °C

10. Desired core size and outer dimensions of transformer

Core size ________ mm or greater

Outer dimensions of the transformer: L ________ x W ________ x H ________ mm max.

11. Safety standard compliance

Electrical Appliance and Material Safety Law    UL    IEC    CSA    Others

12. Safety distance

Primary - secondary: ________ mm or greater

Primary - primary: ________ mm or greater

Secondary - secondary: ________ mm or greater

13. Withstand voltage

Primary - secondary: AC ________ (V) ________ (min) ________ (mA) Secondary - secondary: AC ________ (V) ________ (min) ________ (mA)

Primary - primary: AC ________ (V) ________ (min) ________ (mA) Secondary - core: ________ mm or greater

14. Please Enter the Power Devices to be Used. (Shindengen (MR), Rohm, Sanken (STR), Matsushita (IPD), PI, NSC, etc.)

In addition, if there are recommended transformer specifications, etc., presented by the device manufacturer, please attach these separately.

Manufacturer name: ____________________________

Product No.: ____________________________

15. Mass production and prototyping information

Mass production requested price/currency: ____________________________

Necessary for local contents

Necessary (manufactured by)    Not necessary

Acceptance conditions of the above price, delivery location (FOB CHN, CIF LA., DDP Paris, etc.)

Mass production: Mass production quantity ________ pcs. /M Mass production location ________ Mass production start time ________

Prototyping time: ES1 ________ ES2 ________ MP1 ________ MP2 ________ Approval location ________

16. Required sample quantity ________ pcs. Requested delivery time: ________

17. If there are any other requests (priorities in the company, size or price, etc.) or alterable items, please provide a description.

TDK Corporation  Magnetics Business Group, Business Promotions Dept.

13-1, Nihonbashishi 1-chome, Chuo-ku Tokyo 103-8272, Japan  TEL: 81-3-5201-7229,  FAX: 81-3-5201-7230

• All specifications are subject to change without notice.