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

- All specifications are subject to change without notice.
- 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.

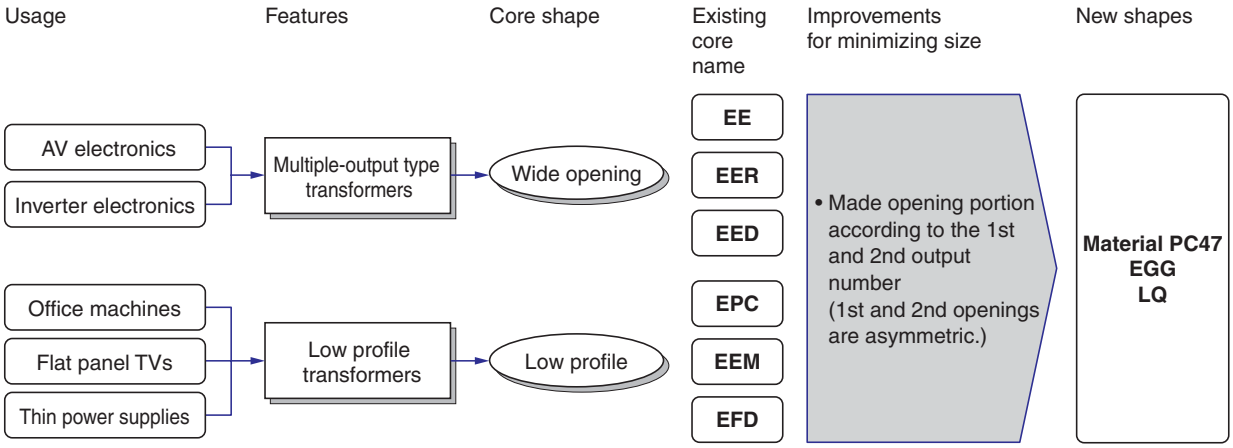
Switching Power Supply Transformers
SRW Series

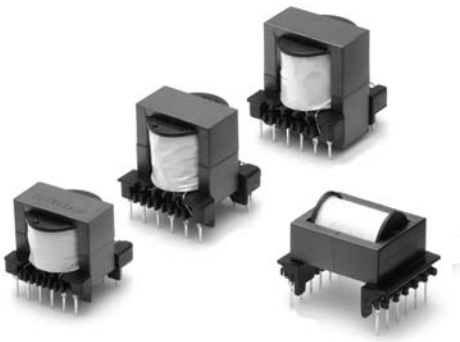
Conformity to RoHS Directive

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)





- 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.

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.

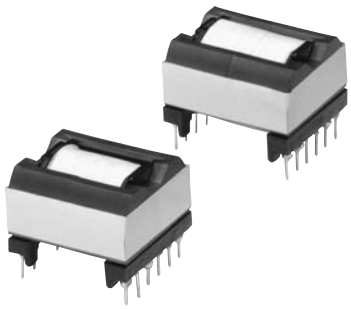
REPLACEMENT PARTS LIST

New transformer	New core*1	Existing core	Bobbin type*2	Maximum external size D×W×H (mm)max.	Maximum output power*3 (W)max.	Switching frequency fsw(kHz)	Cross-sectional center leg area Acp (mm²)	Bobbin terminal		
								Pin pitch (mm)	Lead space F (mm)	Number of pins
For multiple outputs (Vertical type)										
SRW2017EG	EGG2017	EE22	I	24.0×20.0×20.0	15	40	37.1	15	15	12
			II	24.0×20.0×23.5						12
			III	32.0×20.0×23.5						16
SRW2420EG	EGG2420	EER28/22	I	30.0×27.0×25.5	30	40	69.4	P:4.0 S:5.0	18.5/23.5	15
			II	26.5×36.0×26.5				4.0	20.0	16
			III	26.5×32.0×23.5				4.0	20.0	14
SRW2425EG	EGG2425	EER28	I	30.0×27.0×30.5	45	40	69.4	P:4.0 S:5.0	18.5/23.5	15
			II	26.5×29.5×31.5				5.0	17.5	12
			III	26.5×36.0×31.5				4.0	20.0	16
SRW2430EG	EGG2430	EER28L	I	30.0×27.0×35.5	60	40	69.4	P:4.0 S:5.0	18.5/23.5	15
			II	26.5×29.5×36.5				5.0	17.5	12
			III	26.5×36.0×36.5				4.0	20.0	16
SRW2625EG	EGG2625	EER32	I	35.0×31.0×33.0	75	40	80.2	P:5.0 S:5.0	22.5/27.5	17
			II	30.0×30.0×33.0				5.0	22.5	12
SRW2630EG	EGG2630		I	35.0×31.0×38.0	80	40	80.2	P:5.0 S:5.0	22.5/27.5	17
			II	30.0×30.0×38.0				5.0	22.5	12
SRW2826EG	EGG2826	EER35	I	35.0×32.0×33.0	90	40	90.1	P:5.0 S:5.0	22.5/27.5	17
			II	32.0×32.0×33.0				5.0	22.5	12
SRW2833EG	EGG2833		I	35.0×32.0×40.0	100	40	90.1	P:5.0 S:5.0	22.5/27.5	17
			II	32.0×32.0×40.0				5.0	22.5	12
			III	32.0×40.0×40.0				4.0	22.5	18
SRW3435EG	EGG3435	EER38	I	38.0×38.0×40.0	120	40	146	P:5.0 S:5.0	25/30	20
For multiple outputs (Horizontal type)										
SRW2430EG	EGG2430	EER28L	IH	31.0×38.0×29.5	60	40	69.4	5.0	30.0	12
			IIH	31.0×38.0×25.0				4.0		
SRW2630EG	EGG2630	EER32	IH	32.0×40.5×33.0	80	40	80.2	5.0	32.5	12
SRW2833EG	EGG2833	EER35	IH	33.0×43.0×33.5	100	40	90.1	5.0	35.0	12
For single output (Horizontal type)										
SRW24LQ	LQ24	EER28	I	28.0×27.5×22.0	45	60	63.6	4.0	22.5	12
SRW24LQL	LQL24	EER28L	I	31.0×27.5×22.0	60	60	63.6	4.0	25.5	12
SRW28LQD	LQD28	EER28	I	30.5×39.5×22.0	45	40	65.7	5.0	30.0	12

*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.

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 thermorun-away.
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.

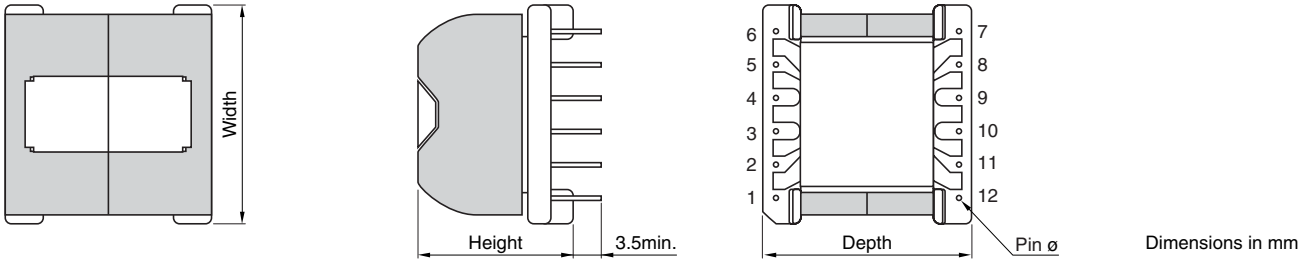
* Compatible material: PC47

APPLICATIONS

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

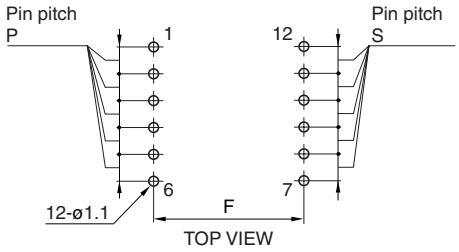
SHAPES AND DIMENSIONS

EXAMPLE: SRW24LQ, SRW24LQL TYPE(BOBBIN TYPE: I)



Dimensions in mm

RECOMMENDED BASE MATERIAL OPENING SIZE



Dimensions in mm

SPECIFICATIONS

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 (mm^2)	Bobbin terminal(mm)			Number of pins	
						Pin pitch	Lead space F	Pin ø	1st side	2nd side
SRW24LQ	I	28.0×27.5×22.0	42	40	63.6	4.0	22.5	0.6	6	6
SRW24LQL	I	31.0×27.5×22.0	45	40	63.6	4.0	25.5	0.6	6	6
SRW28LQD	I	30.5×39.5×22.0	45	40	65.7	5.0	30.0	0.6	6	6

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 thermorun-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.

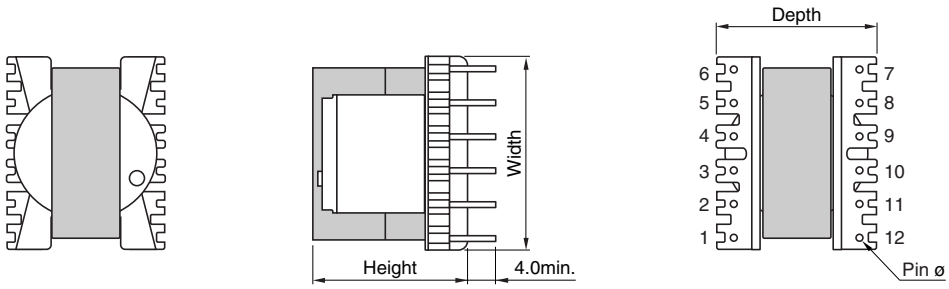
* Compatible material: PC47

APPLICATIONS

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

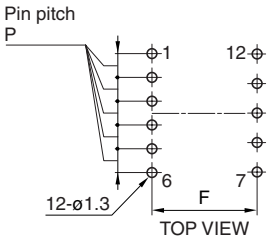
SHAPES AND DIMENSIONS

EXAMPLE: SRW2017EG TYPE(BOBBIN TYPE: I)



Dimensions in mm

RECOMMENDED BASE MATERIAL OPENING SIZE



Dimensions in mm

SPECIFICATIONS

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)			Number of pins	
						Pin pitch	Lead space F	Pin ø	1st side	2nd side
SRW2017EG	I	24.0×20.0×20.0	15	40	37.1	4.0	15	0.8	6	6
	II	24.0×20.0×23.5							6	6
	III	32.0×20.0×23.5							8	8

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 thermorun-away.
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.

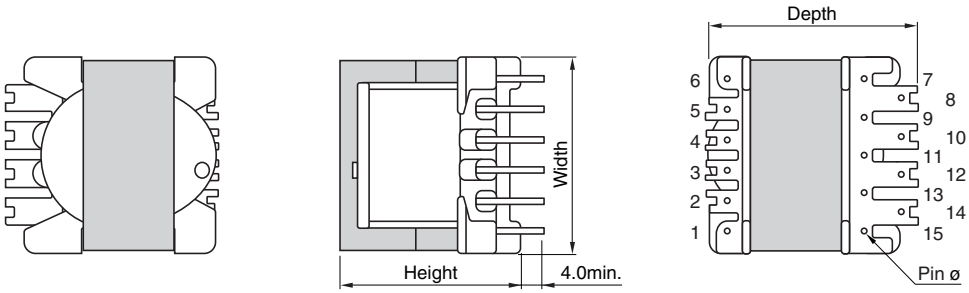
* Compatible material: PC47

APPLICATIONS

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

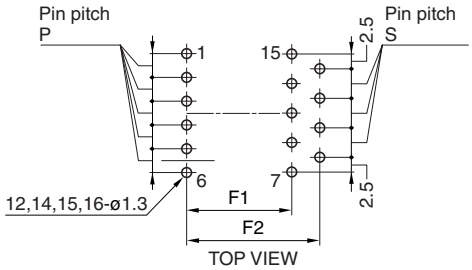
SHAPES AND DIMENSIONS

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



Dimensions in mm

RECOMMENDED BASE MATERIAL OPENING SIZE



Dimensions in mm

SPECIFICATIONS

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)				Number of pins	
						Pin pitch	Lead space F		Pin ø	1st side	2nd side
							F1	F2			
SRW2420EG	I	30.0×27.0×25.5	30	40	69.4	P:4.0 S:5.0	18.5	23.5	0.8	6	9
	II	26.5×36.0×26.5				4.0	20.0		0.8	7	9
	III	26.5×32.0×23.5				4.0	20.0		0.8	6	8
SRW2425EG	I	30.0×27.0×30.5	45	40	69.4	P:4.0 S:5.0	18.5	23.5	0.8	6	9
	II	26.5×29.5×31.5				5.0	17.5		0.8	6	6
	III	26.5×36.0×31.5				4.0	20.0		0.8	7	9
SRW2430EG	I	30.0×27.0×35.5	60	40	69.4	P:4.0 S:5.0	18.5	23.5	0.8	6	9
	II	26.5×29.5×36.5				5.0	17.5		0.8	6	6
	III	26.5×36.0×36.5				4.0	20.0		0.8	7	9

• 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 thermorun-away.
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.

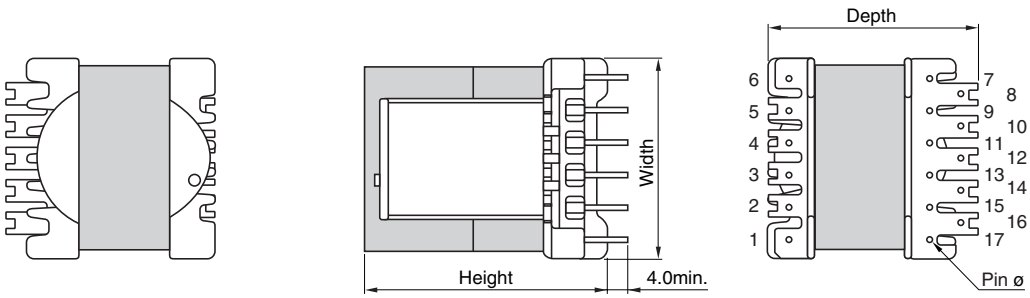
* Compatible material: PC47

APPLICATIONS

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

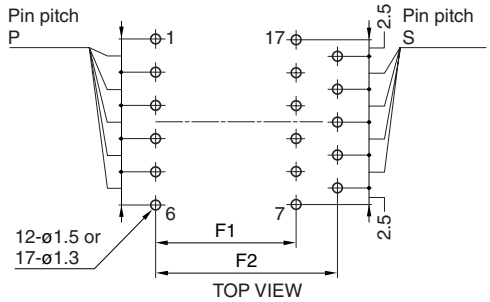
SHAPES AND DIMENSIONS

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



Dimensions in mm

RECOMMENDED BASE MATERIAL OPENING SIZE



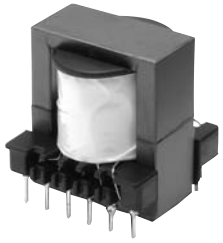
Dimensions in mm

SPECIFICATIONS

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 (mm^2)	Bobbin terminal(mm)				Number of pins	
						Pin pitch	Lead space F		Pin ø	1st side	2nd side
							F1	F2			
SRW2625EG	I	35.0×31.0×33.0	75	40	80.2	P:5.0 S:5.0	22.5	27.5	0.8	6	11
	II	30.0×30.0×33.0				5.0	22.5		1.0	6	6
SRW2630EG	I	35.0×31.0×38.0	80	40	80.2	P:5.0 S:5.0	22.5	27.5	0.8	6	11
	II	30.0×30.0×38.0				5.0	22.5		1.0	6	6

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.

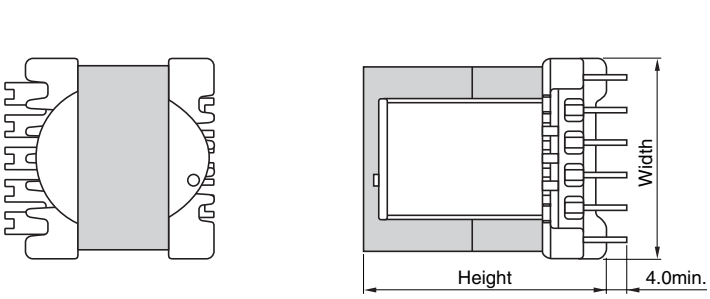
* Compatible material: PC47

APPLICATIONS

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

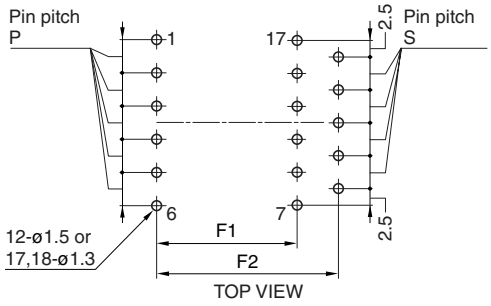
SHAPES AND DIMENSIONS

EXAMPLE: SRW28○○EG TYPE(BOBBIN TYPE: I)



Dimensions in mm

RECOMMENDED BASE MATERIAL OPENING SIZE



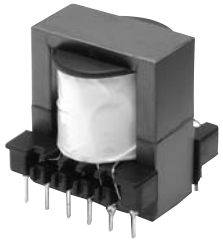
Dimensions in mm

SPECIFICATIONS

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 (mm^2)	Bobbin terminal(mm)				Number of pins	
						Pin pitch	Lead space F		Pin ø	1st side	2nd side
							F1	F2			
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

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.

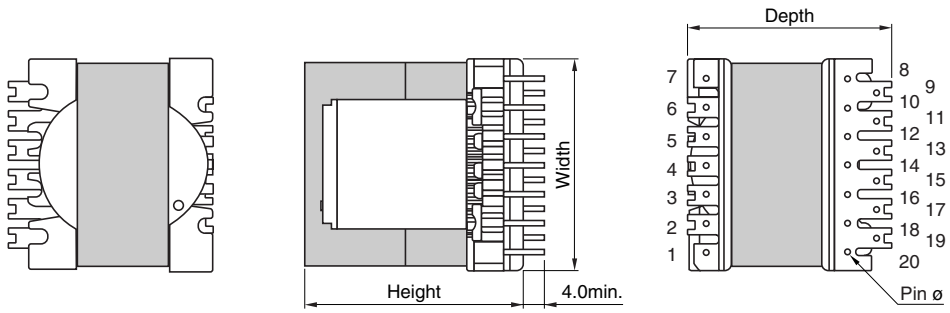
* Compatible material: PC47

APPLICATIONS

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

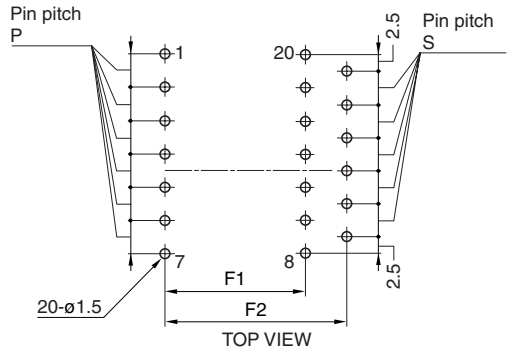
SHAPES AND DIMENSIONS

EXAMPLE: SRW34○○EG TYPE(BOBBIN TYPE: I)



Dimensions in mm

RECOMMENDED BASE MATERIAL OPENING SIZE



Dimensions in mm

SPECIFICATIONS

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 (mm^2)	Bobbin terminal(mm)				Number of pins	
						Pin pitch	Lead space F		Pin ø	1st side	2nd side
							F1	F2			
SRW3435EG	I	38.0×38.0×40.0	120	40	146	P: 5.0 S: 5.0	25	30	1.0	7	13

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.

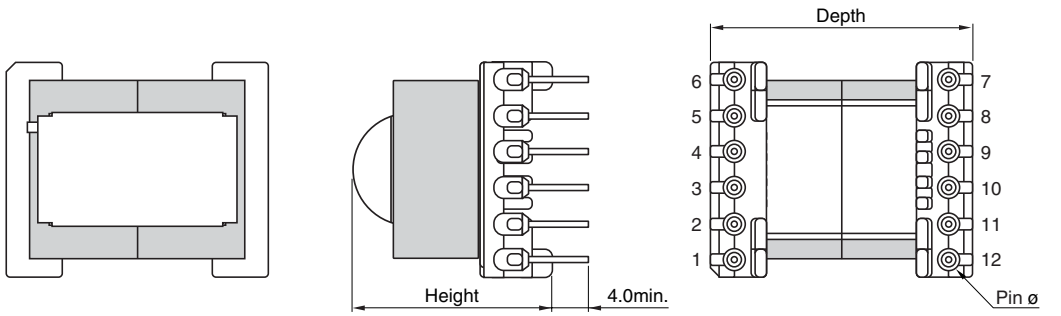
* Compatible material: PC47

APPLICATIONS

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

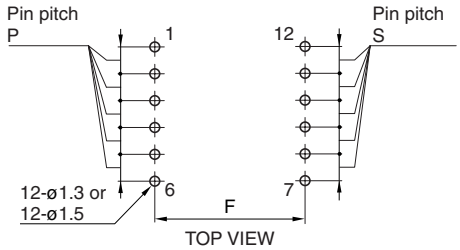
SHAPES AND DIMENSIONS

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



Dimensions in mm

RECOMMENDED BASE MATERIAL OPENING SIZE



Dimensions in mm

SPECIFICATIONS

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 (mm^2)	Bobbin terminal(mm)			Number of pins	
						Pin pitch	Lead space F	Pin ø	1st side	2nd side
SRW2430EG	IH	38.0×31.0×29.5	60	40	69.4	5.0	30.0	0.8	6	6
	IIH	31.0×38.0×25.0				4.0				
SRW2630EG	IH	40.5×32.0×33.0	80	40	80.2	5.0	32.5	1.0	6	6
SRW2833EG	IH	43.0×33.0×33.5	100	40	90.1	5.0	35.0	1.0	6	6

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 A_L-Value

Core shape and size	A_L-value(nH/N²)																
	R10 Series																
	160		200		250		315				400				500		
	R20 Series																
	160	180	200	224	250	280	315				400		450		500		
	R40 Series and other specialty products																
	160	180	200	224	250	280	315	325	350	375	400	425	450	475	500	525	550
For single output(Vertical/Horizontal)																	
SRW24LQ					✓	✓	✓	✓									
SRW24LQL	✓	✓	✓	✓	✓												
SRW28LQD		✓		✓													

Core shape and size	A_L-value(nH/N²)											
	R10 Series											
	100		125		160		200		250		315	
	R20 Series											
	100	112	125	140	160	180	200	224	250	280	315	400
For multiple outputs(Vertical/Horizontal)												
SRW2017EG	✓		✓	✓	✓	✓	✓	✓	✓			
SRW2420EG	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓
SRW2425EG	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓
SRW2430EG	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
SRW2625EG	✓	✓	✓	✓	✓	✓	✓	✓	✓			
SRW2630EG	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
SRW2826EG	✓	✓	✓	✓	✓	✓	✓	✓	✓			
SRW2833EG	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
SRW3435EG	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

Specifications

SPECIFICATIONS

Temperature ranges	Operating	–10 to +60°C
	Storage	–25 to +85°C
Humidity ranges	Operating	30 to 95(%)RH[without dewing]
	Storage	30 to 95(%)RH[without dewing]

GENERAL CHARACTERISTICS

Standard test conditions	Ambient temperature range	+5 to +35°C
	Relative humidity range	45 to 85(%)RH[without dewing]

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

RELIABILITY TESTSRELIABILITY TESTS

Item	Standards	Test methods
Vibration resistance	Standard of inductance, insulation resistance, withstand voltage must be satisfied.	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.
Heat resistance		Measure in normal temperature after leaving in 100±2°C for 96h.
Cold resistance		Measure in normal temperature after leaving in –40±2°C for 96h.
Humidity resistance		Measure in normal temperature after leaving in 60±2°C and 90 to 95(%)RH for 96h.
Temperature cycle		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.

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

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 thermo-couple, 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**

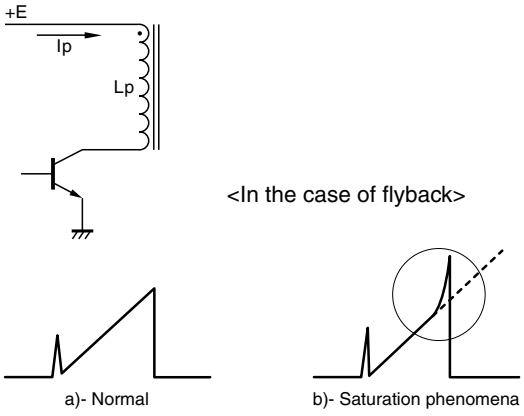
(1)Magnetic operating condition of the core in the transformer are determined by maximum operation temperature (including temperature rise) and driving condition in circuits. If product is used in condition that exceed these conditions, there is a possibility of occurring magnetic saturation of the core. 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 an 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 according 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**

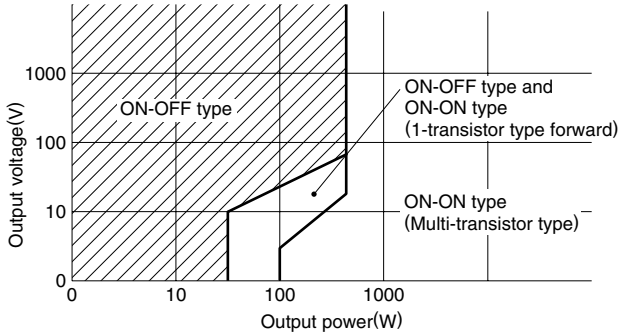
The term “topology” refers to the arrangement of the power components within the switching power supply design. There are several different kind of circuit topologies as following;

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

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

- **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 give us one suggestion when we need to chose topology in given conditions;

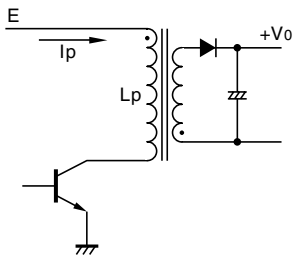


ON-OFF type: For high voltage/small current
ON-ON type: For low voltage/large current

- **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.**



The stored energy in the inductor Lp becomes $W=\frac{1}{2}\times L_P\times I_P^2[J]$

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

$P=\frac{[J]}{[S]}=\frac{1}{2}\times L_P\times I_P^2\times f[W]$

Where,
Lp: Inductance of primary winding
Ip: Peak value of primary current
f: Switching frequency

- **How to decide primary inductance (Lp) in Flyback converter.**

Using the formula $P=\frac{1}{2}\times L_P\times I_P^2\times f[W]$, it is possible to calculate the inductance value needed for the desired output P under the fixed Ip value.
By deriving $E\times T=Lp\times i$ from the formula $E=L_P\times\frac{di}{dt}$, the current which flows through the inductor becomes $i=\frac{E\times T}{L_P}$.
By substituting this with P= ...., the formula of

$P=\frac{1}{2}\times L_P\times\left(\frac{E\times T}{L_P}\right)^2\times f=\frac{1}{2}\times\frac{E^2\times T^2}{L_P}\times f$ results.

From this, the formula $L_P=\frac{E^2\times T^2}{2\times P}\times f$ 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

$N_P=\frac{Emin.\times Tmax.}{\Delta B\times A}$

Where,
Emin: Lower limit value of input voltage [Vdc]
A: Core cross section area [m^2]
D: Duty ratio
Tmax.: The maximum ON time for switching transistor [sec.]
Δ: Operating flux density [T]
Precautions must be taken as the upper limit value of ΔB changes according to core materials, operating temperatures, frequencies, etc.

(2)Forward converter

The calculation formula of primary winding Np 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, ΔB should be slightly lower than that with the frlyback converter.

• Determining of secondary winding

(1)Flyback converter

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

$$N_S = N_P \times \frac{V_O + V_F}{E_{min.}} \times \frac{1-D}{D}$$

Where,

Vf: 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,

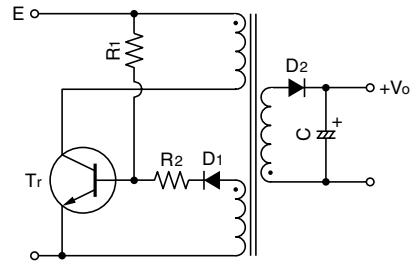
$$N_S = N_P \times \frac{(V_O + V_F + V_L) \times 1/D}{E_{min.}}$$

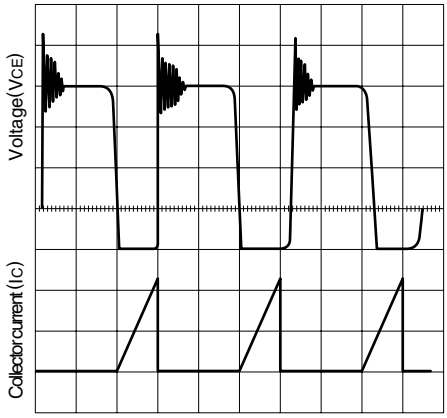
Where,

VL: Voltage drop of the Output filter inductor

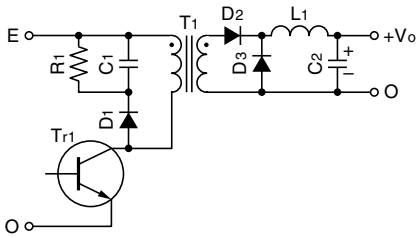
• Example of drive waveforms

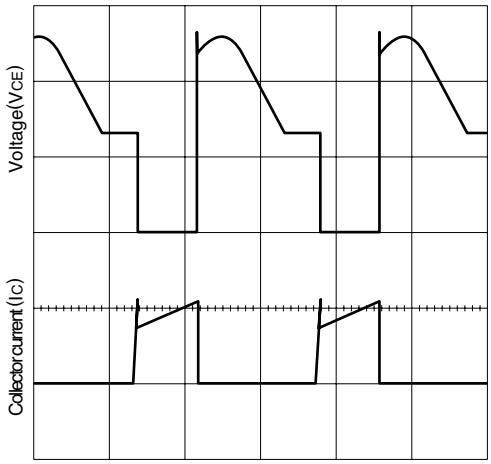
Ringing choke system circuit (RCC)





1-transistor forward type converter





- **In order for designing the transformer, the following conditions are necessary.**

It is greatly appreciated customer give us those conditions by filling out required information with the appended “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 First recovery and Schottky barrier type is different, it will affect to design of number of turns of transformer.

TDK

Transformer for Switching Regulator Specification Request Form

Issued on ____ / ____ / ____

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 voltage/Current/Diode used (diode voltage drop)

Output specifications		Example	Output1	Output2	Output3	Output4	Output5	Output6	Output7	VCC
Power application		Motor								
Output voltage(V) (Accuracy)		50V (±5V)								
Output Current(A)	Minimum	0								
	Typical ΔT measuring condition	0.8								
	Maximum time	1A,10sec.								
	Peak time	2A, 3sec.								
Primary/Secondary		Secondary								
Feedback		No								
Rectifier diode		FRD								
VF(V)		0.1								

Rectifier diode F.R.D: First Recovery Diode, S.B.D: Schottky Barrier Diode

・Request for connection method ☐Yes ☐No (When checking "Yes", please attach a drawing separately.) ・Pin assignments changes ☐Possible ☐Impossible

6. Clock frequency (☐Flexible /☐Fixed) fsw _____ to _____ (kHz)

7. Max. duty or max. ON time D max. _____ (%), T max. _____ (s)

8. Input capacitor capacitance CIN _____ (μF)

(If not specified, design will be performed using a value of ( )μFx4, which is times greater than the output power for 100V and worldwide transformers, and an output power of ( )μF for 200V transformers.)

9. Operating temperature range, max. temperature rise, and ambient temperature _____ to _____ (˚C) ΔT _____ (˚C ☐Typ. ☐Max.) Ambient temperature _____ ˚C

10. Desired core size and outer dimensions of transformer

    Core size _____ 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 _____

    ・Application for a single item purchase ☐Yes ☐Set purchase ☐No (Please bear in mind that the application fee may be borne by the customer.)

    ・Insulation type ☐Basic insulation ☐Reinforced insulation ☐Double insulation ☐Other ( )

    ・Pollution degree ☐1 ☐2 ☐3 (If not specified, design will be performed with a pollution degree of 2.)

12. Safety distance (Please enter the distance prescribed by the company.)

    Primary - secondary: _____ mm or greater Primary - primary: _____ mm or greater Secondary - secondary: _____ mm or greater

    Primary - core: _____ mm or greater Secondary - core: _____ mm or greater

13. Withstand voltage (Please enter the voltage prescribed by the company.)

    Primary - secondary: AC _____ (V) _____ (min) _____ (mA) Primary - core: AC _____ (V) _____ (min) _____ (mA)

    Primary - primary: AC _____ (V) _____ (min) _____ (mA) Secondary - core: AC _____ (V) _____ (min) _____ (mA)

    Secondary - secondary: AC _____ (V) _____ (min) _____ (mA)

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

    Final set name: _____ Mass production requested price/currency: _____

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